COMPARATIVE STUDY OF SCHOOL-RELATED RESOURCES AS DETERMINANTS OF MATHEMATICS ACHIEVEMENT AMONG INTERNATIONAL BACCALAUREATE DIPLOMA LEARNERS IN SOUTH AFRICA AND SINGAPORE

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Abstract

COMPARATIVE STUDY OF SCHOOL-RELATED RESOURCES AS DETERMINANTS OF MATHEMATICS ACHIEVEMENT AMONG INTERNATIONAL BACCALAUREATE DIPLOMA LEARNERS IN SOUTH AFRICA AND SINGAPORE

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Since 1995, South African grade-nine learners consistently performed poorly while Singapore grade-eight learners stayed at the top in the same Trends in International Mathematics and Science (TIMSS) studies (Spaull & Kotze, 2015; TIMSS & PIRLS International Study Center, 2019). However, South African and Singapore grade-twelve learners still need to participate in the TIMSS Advanced Mathematics studies (National Centre for Education Statistics, n.d.-b). That prompted the need for this correlational study that comparatively investigated the difference and the relationship among school-related resources availability, accessibility, and utilisation compared to learner-achievement in IBDP 2 Mathematics AA learners in South Africa and Singapore.

The IBDP schools in Singapore were selected through stratified and simple random sampling, while all IBDP schools in South Africa were part of the main study sample. The IBDP 2 Mathematics AA learners were selected through systematic random sampling. Simple random sampling was also used to select one field test school in South Africa. The current study had a sample size of eight schools and 198 learners, where three schools and 98 learners (52 standard level and 46 higher level learners) were from South Africa, and five schools and 100 learners (50 standard level and 50 higher level learners) were from Singapore. A 170-item questionnaire was used to collect data, and the items were mainly adopted from TIMSS Advance 2025. The instrument used to collect data was reliable and valid. Reliability was tested in the PSPP statistics program, giving Cronbach alpha of 1.0 overall. The validity of the questionnaire was tested in the PSPP statistics program, using a two-tailed test bivariate correlation at $\alpha = 0.05$, where 93% of the questionnaire items were valid. Results indicated a positive relationship: In South Africa - Availability ($R = 0.60$, $R^2 = 0.37$, and $F = 3.66$ at $\alpha = 0.05$, $p = 0.000$); Accessibility ($R = 0.58$, $R^2 = 0.33$, and $F = 3.91$ at $\alpha = 0.05$, $p = 0.000$); and Utilisation ($R = 0.65$, $R^2 = 0.43$, and $F = 3.08$ at

$\alpha = 0.05$, $p = 0.000$). While in Singapore was only Accessibility ($R = 0.58$, $R^2 = 0.34$, and $F = 3.58$ at $\alpha = 0.05$, $p = 0.001$). All positive relationships observed were unreliable as their coefficient of determination (R^2) was very low ($R^2 < 50\%$). Furthermore, no significant differences were found in both countries' availability, accessibility, and utilisation of school-related resources, except in Mathematics achievement ($p = 0.000 < \alpha = 0.05$).

The differences in performance could be a result of other factors. It is recommended that South Africa invest more in pedagogical practice and other educational areas than the school curriculum or resources. Research on pedagogical approaches in IBDP schools should be considered in the future. Further research is needed that will improve the survey questions' reliability levels. Although confirmed, the data's validity and reliability were compromised by the COVID-19 restrictions during data collection. Therefore, the results should be cautiously inferred and could only be inferred from the population studied, IBDP learners in South Africa and Singapore.

Declaration

I declare that this thesis has been composed solely by myself and has not been submitted, in whole or in part, in any previous application for a degree, except where stated otherwise by reference or acknowledgement. The work presented is entirely my own.

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I confirm that I retain the intellectual property and copyright of the thesis submitted. I also allow Unicaf University to produce and disseminate the contributions of the thesis in all media forms known or to come as per the Creative Commons BY Licence (CC BY).

Dedication

I dedicate this book to my wife, Zandile and our four children, Mmapula, Thebana, Keruen and Siphilele. You have shown me the importance of taking my time to cherish each moment and pay attention to life's little thrills. You have made me a better dad by teaching me about life; your child eyes the window I have forgotten over the years of my growing old. I trust that as you learn to rely on Jehovah and from the pages of this book, I might help you discover many of life's wonders. Be motivated, my beloved children.

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Acronyms

TIMSS	-	Trends in International Mathematics and Science Study
IRT	-	Item response theory
IB	-	International Baccalaureate
IBO	-	International Baccalaureate Organisation
IBMYP	-	International Baccalaureate Middle Year Programme
IBDP	-	International Baccalaureate Diploma Programme
IBDP 2	-	International Baccalaureate Diploma Programme Year 2 learners
Mathematics AA	-	Mathematics Analysis and Approaches
Mathematics AI	-	Mathematics Applications and Interpretation
LoLT	-	Language of Learning and Teaching
DBE	-	Department of Basic Education
LTSM	-	Language and Teaching Support Material
NDP	-	National Development Plan
STEM	-	Science, Technology, Engineering, and Mathematics
ToK	-	Theory of Knowledge
ISCED	-	International Standard Classification of Education
IEA	-	International Association for the Evaluation of Educational Achievement
NSC	-	National Senior Certificate
AP	-	Advanced Placement
IEB	-	Independent Examination Board
A-Level	-	Advanced Level
IGCSE	-	International General Certificate of Secondary Education

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CHAPTER 1: INTRODUCTION

South Africa, when compared to Singapore, has not been doing well in grade-eight international Mathematics tests they have been writing since 1995 (Adler & Pillay, 2017; Spaull & Kotze, 2015; Spaull & Pretorius, 2019b). Even when the Trends in International Mathematics and Science Study (TIMSS) team agreed to accept grade-nine in South Africa instead of grade-eight, as is the case with the rest of the world, South Africa still performed very poorly in the TIMSS tests (Spaull & Kotze, 2015). The Department of Basic Education (DBE) has been trying very hard to revamp the education system from grade-R (reception) to grade-12 in recent years with NO success. It indicates that South Africa is trying to fix non-functional train in its education system. However, in Singapore, as a choice and policy of the local Ministry of Education, the TIMSS studies are conducted only on learners doing their national curriculum, not on learners doing the International Baccalaureate (IB) Mathematics curriculum or other foreign curricula.

In South Africa, the TIMSS studies are conducted across all schools, irrespective of the curriculum the schools are offering. To me, the TIMSS studies compare two apple juices that are each made from different types of apples, assuming that the apples, though different, are of the same chemical composition. This research investigated South African and Singaporean learners doing only the well-established international education system, International Baccalaureate (IB) Diploma Mathematics Analysis and Approaches (Mathematics AA). TIMSS Mathematics Advance is the only known international study by the researcher that conducts Mathematics research on grade 12 learners (last grade of secondary schooling) globally. Other studies conduct Mathematics research on lower

grades. For example, the Trends in International Mathematics and Science Study (TIMSS) (for grades 4, 8, and 12), the National School Effectiveness Study (NSES) (for grades 3-5), the Annual National Assessment (ANA) (for grades 1-6), Southern and Eastern African Consortium for Monitoring Educational Quality (SACMEQ) (for grade 6), and Systemic Evaluation (SE) (for grade 3), to check its progress in specific curriculum areas and quality of schooling against worldwide guidelines (Adler & Pillay, 2017; Spaull & Pretorius, 2019; Spaull & Kotze, 2015). However, South Africa and Singapore have not participated in the TIMSS Mathematics Advance studies since their inception in 1995. The current study is equivalent to TIMSS Mathematics Advance. The TIMSS Mathematics Advance equivalence study was conducted for the first time in South Africa and Singapore. In addition, it would be the first time conducted on only International Baccalaureate Diploma Programme (IBDP) learners in South Africa and Singapore. The research instrument used in the current study was adopted from the TIMSS Mathematics Advance international studies.

My original contribution to knowledge is information on South African International Baccalaureate Diploma Programme Year 2 (IBDP 2) Mathematics AA learners compared with IBDP 2 Mathematics AA learners of Singapore. From the literature the current researcher has read, no study similar to mine has been conducted comparing the two countries in IB Diploma Mathematics or IB Diploma Mathematics AA performance. The current study was never performed on IB Diploma Mathematics learners in South Africa. This study helped in identifying the real Mathematics problem in South Africa.

Theoretical Overview of the Study

Learners in every country should be prepared with the mathematical knowledge they need to become effective citizens (Mullis & Martin, 2014). One agrees with the scholars that all countries should have good exit levels for learners as they move to university to do Science, technology, engineering, and Mathematics (STEM). Mathematics understanding should facilitate personal life, helping one to make well-informed financial decisions (Grønmo, Lindquist, Arora, & Mullis, 2015). As the scholars point out, mathematics should improve a country's economic health, improve problem-solving skills, and teach one to persevere and persist. Indeed, Mathematics importance should also be seen in day-to-day life, as the scholars emphasise, such as cooking, counting, building things, managing money, finance and economics, developing software, technology in computing, and many other aspects of our day-to-day activities.

Unfortunately, evidence shows that learners in South Africa perform poorly in Mathematics compared to learners from other regions of the world. Since introducing the TIMSS international Mathematics tests in 1995, South Africa has been performing very poorly and close to number last in grade-nine (Spaull & Kotze, 2015). Disappointingly, lament the scholars, performance in a test conducted in 2011 on grade-nine South African learners in Mathematics indicates that only 2-3% of the learners got above the benchmark set by the TIMSS study centre. As the scholars reiterate, improving grade-R and primary education has yielded fewer results. In an additional effort to curb this problem, add the scholars, policymakers have tried to enhance the curriculum and teaching-learning resources by increasing the number of professional development workshops for

Mathematics teachers over the years. However, the TIMSS 2015 international Mathematics test showed very same poor results for South Africa in grade nine (TIMSS & PIRLS International Study Center, 2019). Surprisingly, the results in South Africa grade-nine were abysmal, according to Spaull & Kotze (2015), even when the testing team put South Africa to a slight advantage, as the TIMSS team was testing grade-eight internationally, not grade-nine. As a consequence, according to the scholars, the poor performance in Mathematics resulted in fewer learners taking Mathematics-related careers at university, resulting in less production of mathematically skilled personnel that are highly needed in South Africa.

TIMSS Advanced estimates patterns of achievement in advanced Mathematics in the last year of secondary school in partaking nations around the globe (Foy, 2017). TIMSS advanced, adds the scholar, also monitors the implementation of curricula and identifies promising instructional practices. TIMSS Advanced has been involved in three assessment cycles so far, points the scholar, in 1995, 2008, and 2015, of advanced Mathematics. For providing comparative perspectives on patterns in achievement based on instructional practices, different curricula, and school organisational approaches, as alluded the scholar above, TIMSS Advanced has collected a rich cluster of background data. However, South Africa and Singapore have never participated in TIMSS Advance since the inception of the study in 1995 (National Centre for Education Statistics, n.d.-a), a study conducted on grade 12 learners or learners doing the final grade in secondary school (IBDP 2).

The TIMSS study focuses on learners in a particular grade, irrespective of the type of curriculum the learners are doing or the country implementing the curriculum. According to Spaull & Kotze (2015), the test administered to the grade-nine learners was fair and was at the grade level. However, the authors conclude that it might be possible that the alignment assumption of the test with the South African curriculum is false. Zuze et al. (2017) strongly suggest that practitioners, researchers, and policymakers must investigate how much teachers need to cover concerning the South African curriculum so that assessment at both local and international levels can be integrated. The conclusion of the scholars reiterates the need to test learners internationally who are doing the same curriculum to minimise or eliminate contravening variables.

Testing learners doing the same curriculum will remove the assumption that poor performance in the TIMSS studies tests resulted from the difference in Mathematics curricula offered in each country. However, suppose the difference in performance is significant after using the same curriculum. In that case, the problem will shift from the curriculum to school-related resources, contextual factors and the practice employed in teaching mathematics in South Africa. Examples of school-related resources are technologies for teaching-learning (internet, computer, calculator), instructional material (textbook), support staff, budget supplies (paper, pencil), school buildings and grounds, heating/cooling and lighting system, instructional space (schoolrooms), relevant library material, audio-visual and video media resources.

Schools doing International Baccalaureate Primary Years Programme (IBPYP), International Baccalaureate Middle Years Programme (IBMYP), or International

Baccalaureate Diploma Programme (IBDP) are called International Baccalaureate (IB) schools (Corlu, 2014). The IB has been significant to international schools over the past few decades (Lee, Hallinger & Walker, 2012). This research seeks to test International Baccalaureate Diploma Programme Year 2 (IBDP 2) Mathematics AA learners in South Africa compared to IBDP 2 Mathematics AA learners in Singapore. The IB curriculum is developed, regulated and implemented by the International Baccalaureate Organisation (IBO), an independent organisation in the United Kingdom (UK). Due to travel restrictions, social distancing, and many more restrictions than different nations imposed because of the outbreak of the COVID-19 pandemic, the current study used IBDP 2 Mathematics AA learners' end-of-previous-year test scores. High-performing countries that lead the world in grade-eight TIMSS 2011 Mathematics achievement were from East Asia (Mullis, Martin, Foy and Arora, 2012). The authors list the countries as Singapore, Korea, and Chinese Taipei. Singapore is among the top countries in TIMSS Mathematics achievement (Mullis & Martin, 2013). Singapore topped all the countries, although it had exclusion from the TIMSS study, such as its private schools, as they predominantly offer foreign curricula (for example, the IB curriculum), which are foreign systems (Laroche & Foy, 2016). Hence, there was a need to conduct this research in IB Diploma Mathematics in South Africa and Singapore.

This study seeks to comparatively study school-related resources as determinants of Mathematics achievement among International Baccalaureate Diploma learners in South Africa and Singapore. This study keeps the Mathematics curriculum the same, both in South Africa and internationally, so we can figure out if school-related resources are

the fundamental determinants of the poor performance of South Africa in Mathematics. The result of this study is my original contribution to knowledge, as there was no study conducted on IB Diploma Mathematics in South Africa in all the literature the current researcher has read. My original contribution to knowledge was the comparison of school-related resources as determinants of Mathematics achievement in South Africa and Singapore when the curriculum was controlled. The study has engaged in a correlational method research design.

Statement of the Problem

There is compelling evidence that South African learners perform poorly in Mathematics compared to other world regions. There are global benchmarking studies South Africa has been participating in, such as the Trends in International Mathematics and Science Study (TIMSS) (for grades 4, 8, 12), the National School Effectiveness Study (NSES) (for grades 3-5), Annual National Assessment (ANA) (for grades 1-6), Southern and Eastern African Consortium for Monitoring Educational Quality (SACMEQ) (for grade 6), and Systemic Evaluation (SE) (for grade 3), to check its progress in specific curriculum areas and quality of schooling against worldwide guidelines (Adler & Pillay, 2017; Spaull & Pretorius, 2019; Spaull & Kotze, 2015). The Mathematics results are not plausible in all the abovementioned studies conducted in South Africa. For instance, in grade-9, South Africa obtained very low scores (on a scale of 0 to 1000) in the TIMSS international Mathematics tests introduced in 1995 (Spaull & Kotze, 2015). In TIMSS 2019, South Africa got 389 points, which placed South Africa in position 38 out of 39 countries, whereas Singapore got position one with 616 points (Mullis et al., 2020). In TIMSS 2015,

South Africa got 372 points, which placed South Africa in position 38 out of 39 countries. In contrast, Singapore got position one with 621 points (International Association for the Evaluation of Educational Achievement (IEA), 2019). In TIMSS 2011, South Africa got 352 points, placing South Africa in 41 out of 42 countries, and Singapore got position two with 611 points (Reddy et al., 2015). In TIMSS 2003, continuing the IEA organisation, South Africa got 285 points, a score that placed South Africa last out of 52 countries, where Singapore got position one with 605 points. In TIMSS 1999, as enlisted by IEA, South Africa got 275 points, a score that placed South Africa last out of 38 countries, where Singapore got position one with 604 points. In TIMSS 1995, concludes IEA organisation, South Africa got 354 points, a score that placed South Africa last out of 45 countries, where Singapore got position one with 643 points. This indicates that South Africa has a severe problem in Mathematics education, and an intervention is urgently needed.

There are some significant interventions South Africa tried to implement as a desperate move to alleviate the problem. Sadly, as Spaull & Kotze (2015) laments, improving grade-R and primary education has yielded fewer results. In an additional effort to curb this problem, add the scholars; policymakers tried to enhance the curriculum and teaching-learning resources and to increase the number of professional development workshops for Mathematics educators over the years. However, the TIMSS 2015 and TIMSS 2019 international Mathematics tests showed poor results for South Africa in grade nine (Mullis et al., 2020; TIMSS & PIRLS International Study Center, 2019). Surprisingly, the results in South Africa grade-nine were abysmal, observed Spaull &

Kotze (2015), even when the testing team gave South Africa a slight advantage, as the TIMSS team was testing grade-eight internationally, not grade-nine. The move from testing grade-8 learners to testing grade-9 learners was made to improve and come up with a strong match between the content information given to TIMSS learners and the covered curriculum in South Africa (Reddy et al., 2015).

South African Independent schools performed higher in Mathematics than South African public schools in the TIMSS International study. For example, in the TIMSS 2015 Mathematics study for grade-9 learners, independent schools got 477 points, while public schools got 341 (Reddy et al., 2016). A repeat of the TIMSS 2011 Mathematics study, reiterate the scholars, independent schools got 474 points while public schools got 324 points. The scholars justify the difference in performance as independent schools have adequate school resources, home resources, and low contextual factors that negatively affect learners' mathematics learning compared to public schools.

On the other hand, Singapore had an exclusion from the TIMSS study. Independent schools cannot participate in the International assessment because they predominantly offer foreign curricula (LaRoche & Foy, 2016). Therefore, a question remains: ' What makes South African independent schools outperformed by Singapore public schools with a big gap if independent schools in South Africa have all the resources for teaching and learning?'. The continuous poor performance in Mathematics suggests an underlying problem somewhere South Africa is unaware of. The current study investigates learners doing the same curriculum in South Africa and Singapore to uncover the truth. The current study investigates whether school-related resources determine

mathematics achievement among International Baccalaureate Diploma Learners in South Africa and Singapore. The current research keeps the curriculum the same in both countries and the school type as I am investigating only International Baccalaureate Diploma Programme Year 2 (IBDP 2) Mathematics Learners in South Africa and Singapore. My original contribution to knowledge is determining if school-related resources determine mathematics achievement among International Baccalaureate Diploma Learners in South Africa and Singapore. Studying learners doing the same programme will help the researcher not worry about aligning the curriculum in both countries.

The TIMSS study focused on learners in a particular grade, irrespective of the type of national curriculum the learners are doing or the country is implementing. According to Spaull & Kotze (2015), the test administered to the grade-nine learners was fair and was at the grade level. However, the authors conclude that it might be possible that the alignment assumption of the test with the South African curriculum is false. Zuze et al. (2017) strongly suggest that practitioners, researchers, and policymakers must investigate how much teachers need to cover the South African curriculum so that assessment at both local and international levels can be integrated. The conclusion of the scholars reiterates the need to test learners internationally who are doing the same curriculum, to minimise or eliminate contravening variables. Testing learners doing the same curriculum will remove the assumption that poor performance in the TIMSS study tests resulted from the difference in Mathematics curricula offered in each country. Suppose the difference in performance is significant after using the same curriculum. In

that case, the problem will shift from the curriculum to school-related resources, contextual factors, or the practice employed in teaching Mathematics in South Africa.

This study seeks to comparatively study school-related resources as determinants of Mathematics achievement among International Baccalaureate Diploma learners doing Mathematics Analysis and Approaches (Mathematics AA) courses in South Africa and Singapore. This study keeps the Mathematics curriculum the same, both in South Africa and internationally, so we can figure out if school resources are the fundamental determinants of the poor performance of South Africa in Mathematics. The results of this study would be my original contribution to knowledge, as there was no study conducted on the IB Diploma Mathematics AA course in South Africa in all the literature I have read. My original contribution to knowledge is comparing school-related resources as determinants of Mathematics achievement in South Africa and Singapore when the curriculum is controlled. The study has engaged in a correlational method research design.

Purpose of the Study, Research Aim, and Objectives

The Purpose of the Study

The purpose of this correlational method research design study is to find:

1. Relationship between school-related resource availability and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore.

2. Relationship between school-related resources accessibility and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore.

3. Relationship between school-related resource utilisation and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore.

The Research Aim

This study investigates the relationship among school-related resource availability, accessibility, and utilisation compared to Mathematics achievement of IBDP 2 Learners in South Africa and Singapore.

Nature and Significance of the Study

The correlational method research design approach was used in this research. This study will mainly use inferential statistics and quantitative data analysis. An Independent sample t-test will be used to compare two independent sample means. As for investigating the relationship between variables, the researcher will use correlation/regression statistical analysis. In addition to these analyses, the researcher will use three distinct item response theory (IRT) models. A three-parameter model will be used with multiple-choice response items, which will be marked as correct or incorrect (dichotomous items). A two-parameter model will be used with response items that have only two response options, which will also be marked as correct or incorrect (dichotomous items) (Martin, Mullis & Hooper, 2016). Finally, a partial-credit model will be used with items with more than two response options (polytomous items). The item response theory (IRT) model will assume that the condition is independent.

Assessments in education can utilise IRT models. IRT models can likewise be used to plan and sharpen scales by incorporating high discrimination items that add to the research instrument's accuracy and reduce the problem of lengthy questionnaire

answering (Kose & Dogan, 2019). The unit of analysis of an IRT model is the item. Therefore, they can be utilised to analyse items from various instruments, given that they measure a similar hidden construct. Moreover, the IRT models (for example, 2 PL and 3 PL) can be utilised in differential item working to evaluate why calibrated items and tests among groups behave diversely (Ali & Istiyono, 2022). The 2PL and 3 PL IRT models can be utilised in computerised versatile testing (Ali & Istiyono, 2022).

According to Bunnell (2011), the IBMYP is not a well-researched program, and it is a less understood curriculum than IBDP and IBPYP. The IBDP was left a secret for a long time, lamenting the scholar, leading to many schools not offering it. The IBDP is also unpopular in South Africa, as there are currently three IBDP schools. Singapore topped all the countries, although it had exclusion from the TIMSS study, such as its private schools. They predominantly offer foreign curricula (for example, the IB curriculum), which are foreign systems (Laroche & Foy, 2016). Hence, there was a need to conduct this research in IB Diploma Mathematics in South Africa and Singapore. The current research focuses on an area never included in TIMSS studies in Singapore: the IBDP schools. This study targets learners from the same curriculum and education programmes in Singapore and South Africa. IBDP 2 learners from IB schools in Singapore and South Africa doing IB Diploma Mathematics are investigated. TIMSS has been conducting Mathematics tests on students doing only national Mathematics curricula in Singapore and on all curricula in South Africa, where South Africa has been performing very poorly. The national curricula are assumed to be the same. TIMSS Advance was never conducted in the past

in either South Africa or Singapore. This study will be conducted for the first time in South Africa and Singapore for grade-12 and IBDP 2 learners.

The South African grade-nine students seem to fall behind the South African curriculum, argue Spaull & Kotze (2015), because the test was fair compared with the South African curriculum. The persistence of the problem, even after the adjustments, suggests that the problem lies with school-related resources or is pedagogical or community-related. The scholars conclude that it might be possible that the alignment assumption of the test with the South African curriculum is false. Even though the scholars acknowledge and assume that the test was fair, it will help, for sure, to use test scores of learners who are doing the same curriculum and same programme. Hence, the focus and cornerstone of this study is the need to conduct the current study only on IBDP 2 learners in South Africa and Singapore.

The target of the South African Department of Basic Education (DBE), according to Zuze and Friends (2017), is to reach the average score of 420 points by 2023 on the TIMSS Mathematics test. However, the question remains: How could South Africa reach that target if the curriculum is not aligned correctly with its international counterparts? The alignment of the curriculum problem further increases the need to conduct the Mathematics test on learners doing the same curriculum and same programme. This heightens the significance of the current research on students doing a controlled curriculum, such as the IB Diploma Mathematics learners in South Africa and Singapore. Visser, Feza and Juan (2015) maintain that having access to resources does not guarantee good performance in Mathematics because learning goes beyond accessing

and improving resources. Therefore, a prominent and significant move is to align the Mathematics curriculum, implying that it should be the same programme as the IB Diploma Mathematics offered in some South African and Singapore schools.

Again, Zuze and colleagues (2017) strongly suggest that practitioners, researchers, and policymakers must investigate how much teachers need to cover the South African curriculum so that assessment at both local and international levels can be integrated. The need to cover the required amount of material in the international assessments indicates that the South African curriculum needs to be peered through to be brought to the same level as the international curriculum. The curriculum concerns heighten the need for this study to test learners who do the same curriculum content and same programme to determine if the problem is with school-related resources or with the curriculum. Zuze and colleagues outline that the National Development Plan (NDP) to 2030 focuses on school management, infrastructure, human capacity, district support and school and community results-accountability. It is noted that there was no mention of aligning the Mathematics curriculum with those of other countries abroad, like Singapore. The alignment of the curriculum heightens the importance of the current study, which seeks to determine whether the problem is with school-related resources, the curriculum, or outside the school-related resources and curriculum. Mullis, Martin, Foy and Arora (2012) also add that well-resourced schools show high achievement in Mathematics. However, the effect of the school-related resources factor needs to be investigated when the curriculum learnt by the learners is the same.

Testing advanced learners in grade-12, justify Mullis & Martin (2014a), provides countries with information that will help them prepare a sound exit level for learners as they move to university to do Science, Technology, Engineering, and Mathematics (STEM). TIMSS is the only international assessment, clarify the scholars, that targets advanced learners to provide important information about their Mathematics. The learners, emphasise the scholars, are assessed in the last year of their secondary education. The current study investigates if school-related resources determine Mathematics achievement in IB Diploma Mathematics learners in South Africa and Singapore. The International Baccalaureate Organisation (IBO) in Cardiff, United Kingdom, runs and controls these programmes.

TIMSS paid more attention to lower secondary syllabi used in Singapore, knowing that Singapore is among the top countries in TIMSS Mathematics achievement (Mullis & Martin, 2013). According to the scholar, the spirit of innovation and creativity is visible in all Singapore schools. The scholar concludes that learners play games and create models for Mathematics through the use of handheld computers. However, a question remains if the excellent performance in Singapore is because they are following a sound and robust curriculum model or because of very supportive contextual factors and school-related resources factors. The current study fills the void by keeping the curriculum the same in all the studied schools while investigating if school-related resources are determinants of Mathematics achievement in IB Diploma Mathematics learners in South Africa and Singapore.

There are very few countries participating in the TIMSS Advanced study. For instance, only nine countries participated in the TIMSS Advanced 2015 study (National Centre for Education Statistics, n.d.-a). Moreover, there was no TIMSS Advanced 2019 study in the recent TIMSS 2019 worldwide study. Therefore, South Africa and Singapore conclude that the NCES organisation has never participated in the TIMSS Advanced study since its introduction in 1995. Therefore, a study conducted on grade-12 or the last grade of secondary school in South Africa and Singapore is significant. Hence, there is a need to comparatively investigate if school-related resources were determinants of Mathematics achievement in IB Diploma Mathematics learners in South Africa and Singapore when the curriculum learnt and the programme covered are the same.

This study seeks to comparatively study school-related resources as determinants of Mathematics achievement among International Baccalaureate Diploma learners in South Africa and Singapore. This study keeps the Mathematics curriculum the same, both in South Africa and internationally, so we can figure out if school resources are the real cause of the poor performance of South Africa in Mathematics. The results of this study would be my original contribution to knowledge, as there was no study conducted on IB Diploma Mathematics in South Africa in all the literature I have read. Therefore, my original contribution to knowledge is comparing school-related resources as determinants of Mathematics achievement in South Africa and Singapore when the curriculum is controlled.

South Africa has been trying to fix its dysfunctional train, so to speak, in its education system for over 20 years now, with no success. The results of this study will

inform South African policymakers, education reformers, teachers, principals, parents, and other stakeholders about necessary interventions needed to improve South African Mathematics achievement to match that of South Africa's international counterpart. My original contribution to knowledge is the knowledge found from investigating school-related resources as determinants of Mathematics achievement in IB Diploma Mathematics learners in South Africa and Singapore. My original contribution to knowledge is the achievement gap in IBDP learners doing IBDP Mathematics in South Africa and Singapore. This study investigates if school-related resources determine Mathematics achievement in IB Diploma Mathematics learners in South Africa and Singapore. This study is NOT investigating the Mathematics achievement gap in South African and Singapore learners. Furthermore, it does NOT focus on each country's national mathematics curriculum. Instead, this study focuses on learners doing the same Mathematics programme and curriculum in the two countries (South Africa and Singapore), IBDP Mathematics AA courses.

Again, this study will inform South African policymakers, education reformers, teachers, principals, parents, and other stakeholders about necessary interventions to improve South African Mathematics achievement to match South Africa's international counterpart. The stakeholders in South Africa should know if the problem is with the South African school-related resources, the South African national Mathematics curriculum, or the pedagogical approach (practice) to Mathematics. This study will examine areas that need reform in teaching Mathematics in South Africa and the IBDP Mathematics AA course. It will inform policymakers where money should be best spent on South African

Mathematics education. The results of this study will be eagerly awaited by policymakers, education reformers, teachers, principals, parents, donors, and other stakeholders. Furthermore, the researcher is also awaiting high anticipation of the results of this study.

Research Questions

Research Questions

Q1.

What is the relationship between school-related resource availability and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore?

Q2.

What is the relationship between school-related resource accessibility and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore?

Q3.

What is the relationship between school-related resource utilisation and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore?

Operational definition of key terms

The following terms are explained in the study's context for a better understanding. These are terms that the researcher used in the study. In addition, the operational definitions of terms for the current study are listed below to assist the readers in having the same level of understanding as the researcher.

Accessibility of school-related resources. In this study, accessibility of school-related resources is when the learners could access available resources. Everyone,

regardless of disability, has ease, equal access and experiences with school-related resources when they want to use them.

Audio-visual resources for the delivery of instructions. These are interactive whiteboards, digital projectors or any technology that helps learners to listen and visualise what is taught.

Availability of school-related resources. In the current study, school-related resources are available when the school or the learner has the teaching-learning material needed.

Computer technology for teaching and learning. Computer technology for teaching and learning refers to computers or tablets for learners.

Discipline. In this study, discipline is using punishment to enforce a code of conduct or rules, teaching a learner to obey rules.

Extra lessons. In the current study, extra-lesson refers to learning and teaching beyond the traditional classroom setting and entails a more deliberate and in-depth focus on a topic already covered in class.

Grades. These marks show how well a learner achieved in his/her Mathematics course.

International Baccalaureate Diploma Programme. The International Baccalaureate Organisation offers this diploma programme, and it prepares learners to excel in college or university careers.

International Baccalaureate Diploma Programme Year 2 learners. These are learners in their final year of the diploma programme that prepares them to excel in college or university careers to lead meaningful lives.

Instructional material. In the current study, instructional material refers to textbooks, handouts, and anything that is used by the educator when teaching Mathematics in the classroom.

Instructional space. Instructional space refers to a classroom or a room used for teaching learners.

Library media centre. In the current study, a library media centre refers to a computer, audio-visual, and organised collection of printed resources managed as a unit in a designated location. It provides students, teachers, and administrators with resources and services.

Mathematics achievement. Mathematics achievement is a Mathematics accomplishment or academic result gained by hard work and quantified with grades.

Mathematics course. Mathematics course refers to a plan of study in Mathematics subject done at the diploma level that leads to an examination.

Mathematics Analysis and Approaches (AA) Higher Level course. In this course, learners require strong algebraic skills and the ability to comprehend straightforward proofs. This course is for learners who enjoy working through challenging problems and enjoy solving them.

Mathematics Analysis and Approaches (AA) Standard Level course. In this study, Mathematics Analysis and Approaches (AA) Standard Level refers to a course

done by learners who enjoy Mathematics problem-solving and generalisation. Exploring the real and abstract application of thoughts fascinates the learners doing this course, with or without the use of technology (IBO, 2023).

Mathematics Applications and Interpretations (AI) course. Mathematics AI course is where learners can investigate and construct Mathematical models thanks to the course's extensive use of technology. In addition, this course develops Mathematical reasoning, frequently concerning practical problems and utilising technology to legitimise guesses.

Mathematics schoolwork. Mathematics schoolwork is a Mathematics piece of work done by learners at school.

Poor. Refers to a learner or family with insufficient money to live a normal or comfortable life in society.

Principal. In the current study, a principal is a teacher in charge of a secondary school and the school community. All of the school's staff, including students, teachers, and support staff, are under the direct supervision of the principal, who is in charge of all major administrative tasks.

Rich. Refers to learners with more money than they need to satisfy their basic wants and needs.

School-related resources. Refers to pieces of material made to make learning and acquiring knowledge easier. Resources can be human or material.

Summer school. These are lessons offered by a school during the summer break or holidays.

School supplies. In this study, school supplies refer to papers, pencils, and materials the school provides for teaching and learning.

The utilisation of school-related resources. School-related resources are used when the learners can use the available resources.

Limitations of the Study

This study is NOT investigating the Mathematics achievement gap in South African and Singapore learners. It is NOT focusing on the national Mathematics curriculum in each country. Furthermore, it is NOT investigating IBMYP Mathematics achievement in South Africa and Singapore because South Africa does not have IBMYP schools. Moreover, this research is NOT investigating IBPYP Mathematics achievement in South Africa and Singapore because South Africa does not have enough samples (it has only one school doing IBPYP). Finally, the study is NOT conducted on IBDP 2 Learners doing the IBDP Mathematics AI course. This study focuses on IBDP 2 Learners doing the IBDP Mathematics AA course. Therefore, this study investigates school-related resources as determinants of Mathematics achievement among International Baccalaureate Diploma learners in South Africa and Singapore.

Organisation of the Dissertation

Chapter 1 describes the thesis, the research problem, and the research questions and provides the theoretical argument. It gives the background of the study, legitimises the study regarding the need that the information will provide, and identifies the research

gap in the literature that the study will fill. *Chapter* 2 reviews and summarises the literature that applies to my research. The literature in this chapter supports the argument and contention made in theory. It identifies the gaps in the literature and how the study fills in at least one of these gaps.

Chapter 3 provides good insight concerning the methods and procedures utilised to address the research questions and repeat the investigation. The sections included analyses, procedures, materials, instruments, and participants.

Chapter 4 discusses the findings of the study. First, the results are deciphered, considering the research questions concerning other scholarly work. Next, it discusses how the findings uphold the exploration discussed in the literature review and the extent to which they add to past studies' discoveries. The chapter lays out the ramifications of the study's findings for Mathematics education. Finally, *Chapter* 5 identifies the limitations of the interpretation of the study and presents implications and recommendations for further research.

CHAPTER 2: LITERATURE REVIEW

Introduction

There is compelling evidence that South African learners perform poorly in Mathematics compared to other world regions. There are global benchmarking studies South Africa has been participating in, such as the Trends in International Mathematics and Science Study (TIMSS) (for grade-4, 8 and 12), the National School Effectiveness Study (NSES) (for grades 3-5), Annual National Assessment (ANA) (for grades 1-6), Southern and Eastern African Consortium for Monitoring Educational Quality (SACMEQ) (for grade 6), and Systemic Evaluation (SE) (for grade 3), to check its progress in specific curriculum areas and quality of schooling against worldwide guidelines (Adler & Pillay, 2017; Spaull & Pretorius, 2019; Spaull & Kotze, 2015). However, the Mathematics results are not plausible in all the abovementioned studies conducted in South Africa. For instance, in grade-9, South Africa obtained very low scores (on a scale of 0 to 1000) in the TIMSS international Mathematics tests introduced in 1995 (Spaull & Kotze, 2015). The following paragraph reveals the positions and scores South Africa and Singapore received from the international assessments.

In TIMSS 2019, South Africa got 389 points, which placed South Africa in position 38 out of 39 countries, whereas Singapore got position one with 616 points (Mullis et al., 2020). In TIMSS 2015, South Africa reached 372 points, which placed South Africa in position 38 out of 39 countries. Singapore got position one with 621 points (International Association for the Evaluation of Educational Achievement (IEA), 2019). In TIMSS 2011,

South Africa reached 352 points, which placed South Africa in position 41 out of 42 countries, whereas Singapore got position two with 611 points (Reddy et al., 2015). In TIMSS 2003, continuing the IEA organisation, South Africa reached 285 points, a score that placed South Africa last out of 52 countries, where Singapore got position one with 605 points. In TIMSS 1999, as enlisted by IEA, South Africa reached 275 points, which placed South Africa in the position last out of 38 countries, where Singapore got position one with 604 points. In TIMSS 1995, concludes IEA organisation, South Africa reached 354 points, placing South Africa in the last position out of 45 countries, where Singapore got one with 643 points. South Africa's performance indicates that South Africa has a severe problem in Mathematics education, and an intervention is urgently needed. The subsequent discussion reveals the positions and scores received by independent schools in the international assessment tests in South Africa.

South African Independent schools performed higher in Mathematics than South African public schools in the TIMSS International study. For example, in the TIMSS 2015 Mathematics study for grade-9 learners, independent schools got 477 points while public schools got 341 (Reddy et al., 2016). A repeat of the TIMSS 2011 Mathematics study, reiterate the scholars, that independent schools got 474 points while public schools got 324 points. The scholars justify the difference in performance as independent schools have adequate school-related resources, home-related resources, and low contextual factors that negatively affect learners' learning of Mathematics compared to public schools. On the other hand, Singapore had an exclusion from the TIMSS study. Independent schools cannot participate in the International assessment because they

predominantly offer foreign curricula (LaRoche & Foy, 2016). Therefore, a question remains: 'What makes South African independent schools outperformed by Singapore public schools with a big gap if independent schools in South Africa have all the resources for teaching and learning?'. The independent schools' performance suggests an underlying problem somewhere that South Africa has not yet discovered.

The current study investigates learners doing the same curriculum in South Africa and Singapore to uncover the truth. The present study investigated whether school-related resources determine Mathematics achievement among International Baccalaureate Diploma Learners in South Africa and Singapore. The current research keeps the curriculum the same in both countries. Further, it keeps the school type the same as I am investigating only International Baccalaureate Diploma Programme Year 2 (IBDP 2) Learners doing Mathematics Analysis and Approaches (Mathematics AA) courses in South Africa and Singapore. My original contribution to knowledge is determining if school-related resources determine Mathematics achievement among International Baccalaureate Diploma Learners in South Africa and Singapore. Studying learners doing the same programme will help the researcher not worry about aligning the curriculum in both countries. Below, the researcher presents the layout of the literature review of the current study.

The review of the related literature begins with the Introduction, followed by subthemes. The first and second subthemes are The Teaching-learning of Mathematics followed by Definitions of Education. The third and fourth subthemes are Achievement and Resources, and Teaching-learning Materials or Resources. The fifth and sixth

subthemes are Performance in Mathematics and Technology used in Schools. The seventh and eighth subthemes are International Baccalaureate (IB) and Personnel Staff members. The ninth and tenth subthemes are Determinant of Performance and Characteristics of Successful Schools. The eleventh and twelfth subthemes are Effective teaching in schools, and Library Databases accessed and Search Engines used. The second theme of the literature review is the Theoretical Framework of the Study. The third theme of the literature review is Mathematics Achievement, with Primary Schools, Secondary Schools, Colleges/Universities, International Schools, and State Schools. The fourth theme of the literature review is Asia-Pacific, followed by the fifth theme, Africa, the sixth theme, Singapore, and the seventh theme, South Africa. The layout of the literature review section continues in the next paragraph.

The eighth theme of the literature review is International Baccalaureate (IB) schools, with subthemes International Baccalaureate Centre, International Baccalaureate Primary Years Programme (IBPYP) Schools, International Baccalaureate Middle Years Programme (IBMYP) Schools, International Baccalaureate Diploma Programme (IBDP) Schools, International Baccalaureate Career-Related Programme (IBCP) Schools, Benefits of the International Baccalaureate Diploma Programme (IBDP), Challenges of the International Baccalaureate Diploma Programme (IBDP), International Baccalaureate (IB) in Africa, International Baccalaureate (IB) in Asia-Pacific, International Baccalaureate (IB) in South Africa, and International Baccalaureate (IB) in Singapore. The layout of the literature review section continues in the next paragraph.

The ninth theme of the literature review is Availability, Accessibility, and Utilisation of School-related Resources, with subthemes Technologies for Teaching-learning Resources, Instructional Material (e.g., textbook) Resources, Support Staff Resources, Educator Resources, Budget for Supplies (e.g., paper, pencil) Resources, School Buildings and Grounds Resources, Heating/Cooling and Lighting system Resources, Instructional Space (e.g., schoolrooms) Resources, Relevant Library Material Resources, Audio-visual and Video media Resources, Challenges of School-related Resources, Possible Solutions for some Challenges of School-related Resources. The last theme of the literature review is Summary. In the next paragraph, the researcher introduces the teaching-learning of Mathematics, its significance, and the definition of Education, achievement and resources.

The Teaching-learning of Mathematics, Definitions of Education, Achievement and Resources

Learning in schools takes part in the schoolrooms, and it is facilitated by educators where learners are at the receiving end. Yi and Lee (2017) conducted a study that examined the attributes of instructional value denoted by intellectual enactment, learner-oriented educator conduct, schoolroom management, and learning support. They found that many of a learner's everyday instructive encounters at school happen in the schoolroom. For example, educators teach educational curriculum materials, and learners develop attitudes, skills, and knowledge by collaborating with educators and their classmates. The scholars conclude that how educators act in the schoolroom and the impacts of these practices on learners' learning have had significant consideration from

scholars and policy developers in the educational field because the nature of guidance scholars and policymakers view as one of the most vital factors intently attached to learners' learning encounters.

Mathematics is one of the non-optional courses in schools. Oktovianus (2019) conducted a study to determine the impacts of utilising video-based instruction on learners' affective and cognitive aspects in the learning of Mathematics. She attested that for primary and secondary educational levels, Mathematics is one of the non-optional courses. Donovan and Lakes (2017) conducted a study examining the implications arising from promotion talks of specific secondary programmes. They found competition in public and independent schools for learners in the United States of America. So, Mathematics must be taught well in schools. Next, the researcher introduces concerns about Mathematics pedagogy used in schools.

There is a concern about Mathematics pedagogy used in schools. Holman, Pascal, Bostan, Hojbota and Constantin (2015) presented two qualitative research on the instructive educational components utilised for cultivating learners' scholastic persistence in the International Baccalaureate (IB) Diploma Programme. They found that individuals spend and put much time into Education. Training is one of the prevalent exercises. Hence, emphasise the scholars, that improving the education system or making elective systems has just increased as of late. Eraikhuemen and Omoregbe (2017) conducted an exploration that examined educators' disposition toward using teaching materials in teaching Mathematics. They observed that to all partners in the educational industry, the teaching and learning of Mathematics had been an issue of concern. The scholars claim

that government, guardians, educators, and learners are keen on compelling Mathematics pedagogy. Next, the researcher presents definitions of Education, achievement, and resources.

Education enables learning, achievement is an ideal result of knowledge, and resources are learning materials. Okigbo and Sunday (2020) conducted a descriptive survey study to help learn principals' school management difficulties. They defined Education as the procedure of enabling learning or the acquirement of beliefs, values, skills, knowledge, and propensities. Akay and Karadağ (2019) described the word achievement as the ideal or desired result one reaches by studying in a planned manner, with the direction of foreordained objectives and goals. Olubunmi (2020) conducted a study to explore teaching-related resources and their effect on learners' Mathematics achievement in secondary schools. They defined resources as a term that alludes not exclusively to teaching materials and strategies yet, in addition to the time accessible for teaching, the skills and knowledge of educators gained through experience and training.

Teaching a skill is a primary learning activity using various methodologies to control, confer concepts, guide, develop abilities, and learn, including understanding non-concrete concepts. Nurcahyono and Novarina (2016) conducted a study that determined the centrality of teaching aids to show essential abilities prepared by general media CD. They found that teaching learners is more than imparting concepts and covering the prescribed curriculum using procedures. The scholars define fundamental teaching skill as a primary learning activity using various methodologies to control, confer concepts, guide, and develop abilities, appreciation, demeanour, standards (desire), and knowledge

toward learners quickly and effectively. Costa, Caldeira, Lopes and Figueiredo (2020) explored minimal cost recordings for learning Mathematics by teaching. They say learning is about change, not just one thing. The scholars say learning might include understanding non-concrete concepts, behaviour development fitting to explicit circumstances, debating ideas, reasoning, acknowledgement, methods and approaches, recalling concepts, and understanding proofs.

Mathematics holds a unique position in the life of each person and the general public. Odo and Ezeudu (2018) conducted a study that examined the accessibility and efficiency of teaching resources and facilities for the execution of Mathematics teaching in higher learning. They stated that Mathematics is as old as humankind and can be defined as a study of numbers. Mathematics holds a unique position in each person's life, and the general public, by and large, add the scholars. Mathematics is crucial in advancing technology, artistry, sciences, and humanities, emphasising the scholars. The scholars conclude that man's Mathematics innovation was fundamental to empowering him to tackle his household and monetary issues. The scholars give a different meaning of teaching as the Science and Art of assisting other people in cultivating their insightful knowledge and comprehension while learning is gaining experience, skills, and understanding. Next, the researcher introduces the teaching-learning difficulties of Mathematics.

Mathematics and its teaching procedures are considered the most challenging part of the school curriculum. Balantes and Tonga (2020) explored quasi-experimental research in a Mathematics lesson to determine the class's impacts when using a

graphing-display-calculator. They found that many learners view Mathematics as one of the most challenging courses in a school curriculum that they would not attempt on the off chance they chose. In comparison, Abirin and Obra (2019) conducted a study to build up a social-media-based Mathematics teaching module for seventh-grade learners. They observed that Mathematics teaching and learning procedures are significant difficulties several educators face in a Mathematics schoolroom. Learners must have an uplifting demeanour and delight in learning Mathematics (Costa, Caldeira, Lopes & Figueiredo, 2020). Costa and Colleagues (2020), add that Mathematics educators continually search for plausible answers to such questions: How can Mathematics educators make learners responsive and more receptive in the schoolroom? Do the learners, as of now, have an inspirational disposition for learning Mathematics? Although Mathematics is taken as a difficult subject/course, next, the researcher introduces the significance of learning Mathematics.

Mathematics is an essential factor in human lives, country development, and the improvement of technology. The vitality of Mathematics in developing countries, Science and technology, and every daily human event have been underscored in the literature (Eraikhuemen & Omoregbe, 2017). Mueni and Githinji (2019) explored the impact of the utilisation of teaching materials on learning Mathematics abilities. They observed that Mathematics is a significant component of human existence. Individuals use Mathematics daily to expedite their lives, add the scholars. Because of its critical worth, as Mueni and Githinji (2019) conclude, teaching and learning Mathematics ought to be handled so that learners can be helped to develop a good mentality towards it. Ramdhani, Suryadi and

Prabawanto (2019) conducted a study that endeavoured to create Mathematics teaching materials. In support, they observed that Mathematics has a significant position in Islam. They say that the Quran keeps the standards of Mathematics as an approach to discovering God's will. Next, the researcher introduces teaching-learning resources.

Teaching-learning Materials or Resources

Teaching materials are needed to improve the learning of Mathematics in the schoolroom. Fisher and Crawford (2020) studied faculty, parents, learners, educators, and staff using Maslow's Hierarchy of Needs in the United States of America. They found that the resources and curriculum accessible inside and outside the school sway the learner's learning, particularly in Mathematics. In their study, Fisher and Crawford (2020) observed that Mathematics is a significant part of everyday life. The scholars claim that Mathematics skills developed early prompts early gaining of Mathematics skills. For viable acquirement of Mathematics capabilities in earlier years, add the scholars; teaching materials are needed to improve Mathematics abilities development. The scholars make an important point that if an educator is not adequately focused on the utilisation of teaching materials for the development of Mathematics abilities, learning would be hindered, causing learners to passively learn Mathematics.

The school board should contribute more to ensure that excellent teaching resources are available. It was additionally discovered by Mueni and Githinji (2019) that teaching materials facilitate acquiring Mathematics skills. Therefore, educators and other vital partners, appeal the scholars, ought to contribute more resources to guarantee accessibility and availability of sufficient teaching-learning materials. The school board,

appeal the scholars, ought to contribute more to ensure that excellent and suitable teaching resources are available to empower learners and educators with all the fundamental prerequisites needed for a superior teaching-learning experience. Therefore, school administrators should always ensure that school-related resources are available, accessible, and usable to educators and learners. The subsequent discussion further raises the importance of school-based resources.

Availability of resources and performance are positively related to each other. Adegoke and Mefun (2016) explored the degree of sufficiency and availability of material and human resources for the execution of Nigeria's recently presented Mathematics school curriculum. They found that successful utilisation of school curriculum and facility availability is positively related. Without the accessibility and availability of teaching materials in schools and valuable foundational infrastructure, reiterate the scholars, the ability-based educational curriculum, regardless of how well it was drafted, will not be adequately executed. Fah and Chandrasegaran (2016) investigated how school resources affect Malaysian and Singapore learners' performance. They indicated that resources are vital for improving teaching, maybe significantly more so in third-world countries than first-world countries, where suitable school material and structural resources can be underestimated.

The degree and nature of school-related resources could significantly affect the quality of schoolroom teaching. Even though 'adequacy' can be relative, say Fah and Chandrasegaran (2016), in each past TIMSS assessment, principals' view of the deficiencies of school-related resources and typical academic performance has been

strongly positively related. Their observation shows that lack of school-related resources significantly positively correlated with learners' performance in Malaysia than in Singapore. They argue that the school learning climate can positively impact an inspirational mentality toward academic brilliance and facilitate schoolroom teaching. They discovered from their study that school-related resources are related to higher performance. Therefore, investing in school-related resources is essential.

The most significant places for Education are the school and family. Guihua and Yangyang (2020) investigated whether various schools show fluctuating degrees of effectiveness in improving learner academic performance and the factors that influence the effectiveness of a school, utilising data from the China Education Panel Survey (CEPS). They observed that the most significant educational places are the school and family. They noted that the influence of the family on learner academic performance had been broadly recognised. Yet, scholars have not agreed on the effects of school-related resources on learner-academic performance or how such products happen (Guihua & Yangyang, 2020). Guihua and Yangyang (2020) and Olubunmi (2020) pointed out an excellent positive relationship between teaching-related resources and academic achievement. The following discussion emphasises the importance of school-based resources.

Availability of resources affects learning and schoolroom climate in schools. Su and He (2020) and Olubunmi (2020) demonstrated that school-related factors are related to their learners' academic achievement in a significant way. Olubunmi (2020) adds that achievement is improved by sufficient availability of teaching-related resources and a

pleasant schoolroom climate for Mathematics learners in secondary schools. Yıldırım (2019) conducted a multilevel modelling analysis study to examine family financial status's direct and aberrant impacts through parents' self-confidence and involvement in learners' mathematics learning. Caygill, Lang and Cowles (2010) researched the availability of learning school-related resources in New Zealand. They found that the absence of resources affects the Education of learners, as frequently pointed out by education reporters. For instance, illustrate the scholars, a mother in the USA pulled her child from a neighbourhood school because of dissatisfaction with what she said was a lack of resources, support staff, and teachers.

School-related resources make Mathematics teaching more effective and efficient. Lee, Walker and Bryant (2018) investigated practices in leadership related to International Baccalaureate (IB) learner-achievement. They found that educators see principals as robust leaders when viewed as successful and effective in designating school-related resources to help educators and learners in their teaching-learning practice. Okori and Jerry (2017) analysed the significance of spontaneous creation in the teaching-learning course of Mathematics in Nigeria. They found that sufficient school-related resources make Mathematics teaching more effective and efficient. Adding that lack of such resources result in non-impressive achievement in Mathematics. Okori and Jerry (2017) suggest that all secondary schools should be supplied and provided with sufficient and relevant resources by educators, the government and all partners in Education for the teaching-learning practice of Mathematics. The school's environment, pointed the scholars, is portrayed as an association or organisation where the production,

improvisation, management, and organisation of resources is taking place to enable learners to gain the most desired learning abilities.

School-based resources give variety and freshness to appeal to learners and enlarge the scope of learners' insight and experience to improve achievement in Mathematics learning. Olubunmi (2020) conducted a study to explore teaching-related resources and their effect on learners' Mathematics achievement in secondary schools. She found that education partners, educators, and school heads should improve educational quality by adequately providing quality teaching-related resources to make the schoolroom environment more amiable for learners to learn Mathematics effectively. The scholar observed that teaching-related resources additionally give variety and freshness to appeal to learners of different capabilities and interests. Teaching-related resources also energise dynamic and active involvement, improve the viability and effects of other materials, enlarge the scope of learners' insight and experience, guarantee progression and order of thought, and give needed fortification (Olubunmi, 2020).

Availability and accessibility of educational resources, as Olubunmi (2020) affirms, improve schools' viability and effects as these are fundamental things that can achieve outstanding academic achievement in learners. Teaching and learning resources assist learners with having generally uniform opportunities and attention to procure and practice aptitudes (Olubunmi, 2020). The teaching and learning resources, according to Olubunmi (2020), make experiences in teaching and learning more rich and more flexible enough to accommodate learners' learning styles. The scholar suggests that instructional resources assist the educator in broadening his learners' learning experience, giving an

essential wellspring of concepts and further exposing the learners to a broad scope of learning practices that expand the proficiency and efficiency of the educator. Availability and accessibility of instructional-related resources in the correct amount improve learner's learning performance (Olubunmi, 2020). However, a question remains as to which is the right amount of instructional-related resources.

Insufficiency of material and physical resources in schools is the main element liable for the learning results of learners. Schools with insufficient facilities, such as libraries, schoolrooms, and teaching-learning materials, will probably not perform well (Olubunmi, 2020). First, the scholar reveals that the World Bank shows that resource accessibility and availability in schools is insufficient regarding learner textbook appropriation, infrastructural resource accessibility and availability, and learner-educator proportionality. Next, the researcher introduces performance in Mathematics.

Performance in Mathematics

Different countries have used TIMSS and PISA worldwide to evaluate achievement in Mathematics. In their analyses, Fah and Chandrasegaran (2016) revealed that Singaporean Mathematics learners have reliably been outpacing their colleagues on each Trends in International Mathematics and Science Study (TIMSS) series since 1995. The scholars described TIMSS as global research employed by the International Association for the Evaluation of Educational Achievement (IEA) since 1995. As the scholars point out, it was intended to evaluate the teaching-learning quality of Mathematics and Science for grade 4 and grade 8 learners in different countries. Ledger (2017) led a critiquing meta-analysis review of the literature study on the International Baccalaureate (IB)

publications from 2009 to 2015. She found that worldwide evaluation instruments, for example, TIMSS and PISA, are being utilised to gauge countries' performance levels, thus increasing public pressure innate in serious and competitive rankings.

South Africa has not been positioned well in international Mathematics tests. The scholars, Vermooten, Malan and Boonzaier (2020), state the Global Competitiveness Index Report 2017-2018 that South Africa was positioned 114th out of 124 countries in a study that positioned the nature of 124 countries' education systems. The outcome is in line with results from other international tests between 2002 and 2016, reveal Vermooten, Malan and Boonzaier (2020), for example, the Trends in International Mathematics and Science Study and Progress in International Reading Literacy Study, have reliably announced comparative degrees of educational accomplishment in South Africa. Next, the researcher introduces factors that influence achievement in Mathematics.

Communication abilities, gender, vocabulary level, educator factor, involvement of parents, financial status, language, and intelligence influence achievement in Mathematics. Odo and Ezeudu (2018) plead that when teaching, educators should do it in a manner and way that all learners in the schoolroom can perform at a significantly high level. Prado, Tan and Capuyan (2020) led an investigation to determine the effectiveness of the material created in High School Statistics and General Mathematics. They found that there are significant non-mathematical factors that are identified with performance in Mathematics. These incorporate communication abilities, gender, vocabulary, educator factor, involvement of parents, financial status, language, and intelligence (Prado, Tan & Capuyan, 2020). Therefore, Prado, Tan and Capuyan (2020) state that educators must

utilise methodologies that enhance learning in complementing their pedagogical administration.

There are numerous different components associated with the academic achievement process. Superville (2017) conducted a perception-based study of significant stakeholders on educator effectiveness in Trinidad and Tobago. She found that learners are disadvantaged in many ways when educators are ineffective in the schoolroom. In this failed system, learners experience academic disappointment, add the scholar, become estranged with school, and quit school. They will, in general, take part in delinquent conduct (Superville, 2017). Superville (2017) claims that stakeholders in Education see a successful educator as one with solid pedagogical skills. A successful educator incorporates the accompanying, as Superville (2017, p. 57) suggests: Using applicable educating and learning aids in one's lesson; Utilising an assortment of instructional systems; Being ready to finish the syllabus; The capacity to clarify content plainly and clearly; Make learning charming and fun; Engage in early planning. It is significant to note, continues the scholar, that educator effectiveness is not the main or only supporter of learner life and academic accomplishment. The scholar concludes that numerous components are associated with the academic achievement process. Next, the researcher introduces additional factors that are determinants of performance in schools.

Community context, friends, school, family, and individual are also determinants of performance in schools. Zaff, Donlan, Gunning, Anderson, McDermott and Sedaca (2017) conducted meta-analysis research from the previous 25 years on secondary school achievement or graduation, zeroing in on longitudinal, US-based investigations of

flexible elements predictor of graduation. They found that secondary school achievement or graduation predictors are community context, friends, school, family, and individual. Agasisti and Longobardi (2017) investigated resilient learners, schools' characteristics, and equal educational opportunities by utilising data from the OECD-PISA 2009 survey. The scholars found that, by and large, learners' characteristics and the background of their families have a much more enormous influence over accomplishment or achievement than school factors.

The learner's academic achievement increases with the increase in the educational levels of the parents. In his study, Aslan (2017) explored learner triumphs in transitioning to secondary-based Education from primary-based education examination through some factors that are non-school based. He found that the learner's academic achievement increases with the educational levels of the guardians or parents and the yearly school expenditure for the learner. Kushner, Cochise, Courtney, Sinnema and Brown (2016) led an assessment in Aotearoa, New Zealand, that analysed the International Baccalaureate (IB) Primary Years Program (PYP). They found that the outcomes from the state test examination utilised in their investigation demonstrated that performance in the PYP schools commonly surpassed performance among other high docile schools countrywide. Next, the researcher introduces the role played by sound learner-educator relationships and attitudes.

Good learner-educator relationships and attitudes play a significant role in school learner performance. Barnett, Avila and Aklog (2017) analysed how International Baccalaureate (IB) Diploma Program (DP) schools and schoolrooms encourage and build

up learners' non-intellectual aptitudes and, specifically, positive academic mentality. They found that learners with a "development" mentality instead of a "fixed" mentality are bound to be successful learners and accomplish great academic results (2017, p. 1). They add that a development attitude includes the conviction that it is conceivable to be a prosperous learner dependent on effort and not simply natural characteristics, for example, intelligence. Arends and Visser (2019) give experimental proof of how learners' perspectives towards educators added to their feeling of school belonging and their Mathematics performance. Their investigation confirms the critical role a sound learner-educator relationship plays in academic achievement and a healthy perspective of school belonging. As the scholars conclude, the school environment should be overseen to consider coaching and mentoring relationships among learners and educators to be reinforced. Next, the researcher introduces physical school-related resources, school discipline, and school atmosphere as significant predictors of achievement.

Physical school-related resources, school discipline, and school atmosphere predict achievement in a significant way. Akay and Karadag (2019) conducted a multilevel examination of school, parent and learner achievement indicators in secondary school progress in Turkey. They observed that even though the school-based variables were identified as having little effect on learners' academic achievement during the 1970s, later explorations zeroing in on school effectiveness demonstrated that schools make a difference. The scholars add that physical school-related resources, school discipline, and school atmosphere predict achievement significantly. Learners who finish tasks given by the educator and study at a school effectively achieve better on tests (Akay & Karadag,

2019). Effective resource allocation is associated with leadership that is most compelling and influential in improving learners' learning outcomes (Lee et al., 2018; Olubunmi, 2020). A question remains if school-related resources account for the differences in Mathematics performance among learners doing IB Diploma Mathematics Analysis and Approaches courses in South Africa and Singapore.

There is an association between school-related resources and learner performance. BenDavid-Hadar (2018) developed a composite funding formula for school resources to promote equity and improvement. She found that the allocation of resources influences the achievement in Education. Guihua and Yangyang (2020) found that school-related resources in developing countries' schools affect learner academic achievement when contrasted with those in first-world countries. They add that there is an association between school-related resources and learner performance. Guihua and Yangyang's study (2020) identified that a school's general financial status, the learner-academic level at admission, and the availability of school-based facilities and school-material resources could improve learner-achievement partly and all the more successfully. They advised that the availability of school-related resources also mirrors a school's limit to attract, mobilise, and gather resources. Therefore, the school can utilise these resources to improve learner-academic advancement (Guihua & Yangyang, 2020; Olubunmi, 2020). The scholars conclude that learner-level factors, such as learning propensities and learning background, assume a more significant function in advancing academic achievement.

School factors can add value, which improves learner achievement in schools. Su and He (2020) conducted a multilevel modelling analysis in China on learners and school-related factors associated with achievement in Mathematics of senior secondary school minority learners. Their observational proof has demonstrated that school factors are significantly related to the educational attainment of their learners. School- and home-related factors positively influence learners' Mathematics achievement (Yıldırım, 2019). In Turkey, emphasise the scholar, school-factor is by all accounts more significant, for learners' Mathematics achievement. Laukaityte and Rolfsman (2020) conducted a study identifying factors in the school's environment concerning learner performance in Mathematics in PISA in the Nordic countries. They observed that school factors could add value, which improves learner achievement, paying little heed to the attributes or characteristics of the learner.

PISA and TIMSS enormous scope assessment revealed that school-level factors appeared to be associated with learner achievement. Generally, as Laukaityte and Rolfsman (2020) relate, a small number of school-level factors appeared to be related to learner achievement. They discovered that past research, based on PISA and TIMSS enormous scope assessment data, uncovered that a small number of school-level factors appeared to be related to learner achievement. In their analyses, no school-level factors in Sweden were significantly found to effectively correspond to achievement in Mathematics in TIMSS. Laukaityte and Rolfsman (2020) conducted a study identifying factors in the school's environment about learner-performance in Mathematics in PISA in the Nordic countries. They found that hardly any school-related factors generally

appeared to be related to learner attainment at all achievement levels in 2003, just as in 2012. Next, the researcher introduces the technological influence on Mathematics learning.

Imbuement of technology considerably modifies the teaching and learning of Mathematics. In their study, Varier, Dumke, Abrams, Conklin, Barnes and Hoover (2017) observed that learners and educators portrayed positive self-direction after utilising technology gadgets. The scholars noticed that learners illustrated that their devices assisted them in looking up concepts they missed before asking the educator. In Varier, Dumke, Abrams, Conklin, Barnes and Hoover's (2017) analyses, educators depicted models where learners investigated answers alone and worked together to problem-solve. Zaenal, Anuradha and Roberta (2018) studied across two groups of learners and genders the affective domain in Mathematics learning with technology. One group of learners utilised individual gadgets, while the other shared learning implements in Indonesia. They found that incorporating technology into teaching quickly turns into an expected standard.

In Mathematics Education, the imbuement of technology considerably modifies the teaching-learning of Mathematics. The scholars advise that affordances of technology permit the increase of new resources to Mathematics content and practice teaching methods in distinctive ways. Zaenal, Anuradha and Roberta (2018) add that technology gives educators the instrument to associate Mathematics theories with real-life challenges so their learners can investigate Mathematics concepts and dissect or analyse circumstances as they solve the problems. The scholars strongly attest that schools in

the countryside are disadvantaged because they do not have technology accessibility. Next, the researcher introduces the role learners' perception has in school performance.

Learners' perception of themselves also plays a significant role in school performance. Lester and Lochmiller (2015) explored the perception of educators, learners and principals as learning methods and working inside four Primary Years Programme (PYP) schools in Colombia. They found that learners viewed themselves as learners who mostly accepted that they were academically successful. Over 60% (63.1%) of learners concurred with the assertion, "I am prosperous as a learner" (Lester & Lochmiller, 2015, p. 4). Furthermore, the scholars observed that the learners' general perception was that their prosperity mainly depended on working hard. Over 80% (84.1%) of learners concurred with the assertion, "I will consistently be prosperous if I work diligently" (Lester & Lochmiller, 2015, p. 4). Barnett, Avila and Aklog (2017) analysed how International Baccalaureate (IB) Diploma Program (DP) schools and schoolrooms encourage and build up learners' non-intellectual aptitudes and, specifically, positive academic mentality. They also found that achievement is primarily a result of hard work. Lester and Lochmiller (2015) admit that these reactions show that learners positively perceived their capacities as learners and understood that their prosperity as a learner was reliant upon working hard and commitment. Next, the researcher explains how the 45-point system works in IBDP.

The IBDP uses a 45-point system in their external examinations. Lee, Walker and Bryant (2018) investigated what administrative practices are related to International Baccalaureate (IB) learner performance. They found that a learner's IBDP's highest score

is 45 points. Six subjects multiplied by 7 points and three points from the Extended Essay and Theory of Knowledge add the scholars. The lowest score for awarding the diploma is 24 points (Lee et al., 2018). Beech, Guevara and del Monte (2018) examined the execution of the International Baccalaureate (IB) Diploma Program (DP) in state-funded schools in Argentina, Peru, and Costa Rica. They found that contrasted with non-public schools, be that as it may, state schools in each of the three nations have lower Diploma pass-rates. Next, the researcher presents technology used in schools in the literature review.

Technology used in Schools

Technology in the 21st century should be presented in schoolrooms in manners that align with educators' present methodologies in Mathematics. Varier, Dumke, Abrams, Conklin, Barnes and Hoover (2017) examined the utilisation of six technological gadgets in 18 high, middle, and primary school lessons. They observed that traditional learning conditions have not successfully kept learners engaged in school learning. They also noted that conventional learning conditions have likewise not been successful in preparing learners for the workplace demands of the 21st century. Software school-related resources give differentiated tasks to learners, contingent upon their degree of comprehension (Fisher & Crawford, 2020). Tondeur, van Braak, Ertmer and Ottenbreit-Leftwich (2017) examined 14 studies on teachers' pedagogical beliefs and their educational uses of technology. They found that technology integration fails because those associated with the change are not at the same level of understanding of the reason appended to that change.

Technology should be presented in manners that align with educators' present methods. Technology integration should not be an independent exercise zeroing exclusively on specialised skills (Costa et al., 2020; Gain & Ancho, 2019; Stohlmann & Acquah, 2019). The scholars also found that all partners, such as administrators, educators, parents, and board members, should have a mutual vision to make supportable and effective educational changes incorporating technology. A well-rounded education consolidating meaningful technology integration needs school policies and a supportive environment (Costa et al., 2020; Gain & Ancho, 2019; Stohlmann & Acquah, 2019). The authors highlight that to appeal to educators' values and improve the probability that educators will incorporate and utilise technology, notwithstanding educators' pedagogical methodologies, technology should be presented in manners that align with educators' present methods. Next, the researcher elaborates on specialised and pedagogical support in using ICT in schools.

Specialised support and pedagogical support are imperative for properly utilising technology in schoolrooms. Celik, Karakus, Kursun, Goktas and Ozben (2017) investigated pedagogical problems experienced by educators and learners in Turkey. The scholars found that generally, it is acknowledged that the best method of preparing individuals for the 21st century is integrating educational information and communication technologies (ICTs) (Gain & Ancho, 2019). Drossel, Eickelmann and Gerick (2017) conducted a study determining the secondary educators' recurrence of PC use in class. The scholars found that the utilisation of technology in teaching-learning educational settings has been explored globally. However, its hugeness has been a repetitive topic

regarding educational practice for over 40 years (Drossel et al., 2017). Regarding expanded digitalisation in all circles of life, the accentuation has accordingly re-evaluated teaching for consolidating ICT into Education (Drossel et al., 2017).

Concerning school-based resources, the principal angle that rings a bell is the ICT hardware of schools that, positions among the most important elements concerning ICT incorporation in the lesson. Access to resources comprises one of the imperative forerunners for utilising ICT in a lesson (Drossel et al., 2017). The accessibility to resources is additionally validated, emphasising the scholars, by various investigations that have distinguished ICT availability in schools as a critical factor concerning its utilisation for learning. They further point out that access to resources comprises one of the imperative forerunners for utilising ICT in a lesson. Drossel, Eickelmann and Gerick (2017) conclude that lack of specialised support, pedagogical support, and any other deficiency regarding help has been distinguished as one more hindrance at the school level for educators utilising ICT. Drijvers, Monaghan, Thomas and Trouche (2014) explored using and incorporating technology into educational plan, lesson practices and learning in secondary Mathematics subjects. They observed that scholars reliably show that organising schoolroom-related resources is critical. Learners' learning is touchy and sensitive to slight contrasts in utilising PC-based undertakings.

Educators require a learner-centred, innovative or technology-rich school climate (Varier et al., 2017). Johns, Troncale, Trucks, Calhoun and Alvidrez (2017) studied learner-engagement benefits and tips for utilising four specific applications or projects (Seesaw, Educreations, Google Classroom, and Facebook) to improve learner

engagement. They found that engaging learners in a lesson is a motivating apparatus for effective educators. They also noted that it is a challenge to keep learners effectively occupied with learning in the schoolrooms of the twenty-first century. They observed that educators frequently battle to contend with social media, gaming systems, handheld gadgets, and other entertaining distractions. Johns, Troncale, Trucks, Calhoun and Alvidrez (2017) advise that schoolroom educators in the twenty-first century need learners to think critically, share information, be collaborative, and be creative.

Technology can assist learners with discovering new concepts in a Mathematics schoolroom. Zaenal, Anuradha and Roberta (2018) investigated across two groups of learners and genders the affective domain in Mathematics learning with technology. One group of learners utilised individual gadgets, while the other shared learning gadgets in Indonesia. Schools are frequently the primary social stage where computerised capacities are grown, highlighting scholars. Accordingly, Zaenal, Anuradha, and Hunter (2018) strongly suggest that schools are significant for conducting research associated with equitable development. The scholars reiterate that technology can assist learners with discovering new concepts, and educators must plan challenges that go past just entering figures to develop participation and dialogue among learners. The scholars advise that although incorporating technology into education programmes offers numerous paths for educators to engage with learners, we must focus on learners' viewpoint toward technology utilisation. Yemini and Dvir (2016) conducted a study to uncover the force relations and clashing interests in the local-worldwide nexus of the Israeli state-funded system of Education. They found that nations' educational systems intended to spread

values and thoughts fundamental to the development of a country are currently needed to address changes in technology to stay competitive in a dynamically ever-changing world. Next, the researcher introduces the International Baccalaureate (IB).

International Baccalaureate (IB)

International Baccalaureate (IB) schools have been the quickest-developing subset of worldwide Education. Resnik (2019) conducted a study analysing the IB Diploma – Higher Education admission in the United States of America, Spain, Chile, Canada, and Argentina. She found that Education worldwide observed a move from best to bulk schooling over the most recent years. The increase of the learner populace goes along with a high rate of failure, adds the scholar. Lee, Walker and Bryant (2018) investigated practices in leadership related to International Baccalaureate (IB) learner-achievement. They found that lately, research studies have zeroed in on the difficulties experienced by leaders in IB schools because IB schools have been the quickest-developing subset of worldwide Education far and wide. In addition, they noticed that IB world-schools share some similitudes with non-IB world schools regarding effects and practices of leadership.

The International Baccalaureate programmes are known to be rigorous programmes in schools' curricula. Wright, Lee, Tang and Tsui (2016) compared the inspirations of IBDP and IBMYP Coordinators for picking the IBMYP in Asia-Pacific with Coordinators from different areas of the globe. They found that the International Baccalaureate (IB) has become a fantastic brand in educational systems worldwide in recent years. Furthermore, the scholars point out that numerous individuals have viewed

the offered programmes by the IB as providing a powerful blend of reformist pedagogical approach and academic rigour. The view about the IB programmes mentioned above continues in the next paragraph.

The IB Diploma programme is considered the most vigorous secondary school programme. Holman, Pascal, Bostan, Hojbotă and Constantin (2015) presented two qualitative research on the instructive educational components utilised for cultivating learners' scholastic persistence in the International Baccalaureate (IB) Diploma Programme. They observed that the International Baccalaureate (IB), a worldwide independent education system, offers a two-year school preparatory educational curriculum known as the Diploma Programme. Perna, May, Yee, Ransom1, Rodriguez and Fester (2015) conducted a study investigating whether learners from low-pay families can profit from the International Baccalaureate Diploma Program (IBDP), the most rigorous programme offered in secondary schools. They found that some forces, like academic preparation inadequacy limit college accessibility by learners.

The academic preparation inadequacy results from a lack of academic rigour in the courses offered in a secondary school the learner attends. The learner might be under-participating in rigorous courses accessible in the school (Wathall, 2016). The IBDP is being introduced in many independent and public schools (Wathall, 2016). Thus, the IBDP became a worldwide education influence (Resnik, 2019). Saavedra (2014) conducted a study examining whether admission to the IBDP builds learners' academic achievement. She found that the International Baccalaureate Diploma Programme (IBDP) was initially established as a private system of Education for ambassadors' children to

acquire a globally perceived secondary school diploma. She explained that schools authorised to offer International Baccalaureate programmes are called "IB World Schools" by the International Baccalaureate Organization (IBO).

Educators utilise the International Baccalaureate programme curriculum and instructional method or pedagogy to train a scope of courses prepared to prepare International Baccalaureate(IB) learners for university or college (Saavedra, 2014a). Wathall (2016) explored new initiatives taken from the International Baccalaureate programme that advance a sound mathematics teaching structure. She found that more than 1,000,000 learners far and wide are pursuing their studies through the IB programmes. Furthermore, she indicated that an expanding number of independent schools are introducing IB programmes to create caring, knowledgeable, and inquiring learners who are inspired to succeed. Next, the researcher introduces personnel staff members as another vital school resource.

Personnel Staff Members

Human resource in schools helps in the achievement of the educational goals. Okigbo and Sunday (2020) conducted a study to determine principals' difficulties and challenges in secondary schools in Nigeria. They found that staff management is challenging in all companies yet unmistakably challenging in schools. In every school, say the scholars, the human resource personnel is the most indispensable and helpful resource. Personnel alludes to the people involved in the school's everyday running (Okigbo & Sunday, 2020). The scholars argue that personnel in Education are critical because they are knowledgeable and have the skills and abilities to execute their different

separate responsibilities or tasks, such as managing resources effectively, maintaining school resources, research, and teaching. The scholars reiterate that the significance of human resource management in schools is that it helps achieve the educational goals, detecting future and current human resource necessities to evade personnel deficiencies. The welfare services of school staff cannot be overemphasised (Okigbo & Sunday, 2020). The scholars clarify that this involves providing social luxuries at school, service conditions, prompt and adequate payments of remunerations and stipends, award of maternity leave, award of sick leave, and study leave, to name but a few.

School staff must be protected from the unsafe environment because it can affect teaching-learning. Ada and Msughter (2019) conducted a study that examined the relationship between overseeing teaching that impacts and personnel management in secondary school in Benue. They found that if school staff are not appropriately taken care of and overseen, it will not forecast well with the school system as low-quality and ill-prepared school leavers will be conveyed to the work market without gaining the ideal skills to add to the economy. Appropriate management of school staff in the life of the school adds incredibly to running the school smoothly (Ada & Msughter, 2019). Thus, adding the scholars will likewise assist with tackling individual and social issues that may make the school administration malfunction. Secondary schools' heads of schools and the government ought to guarantee that school staff is protected from unsafe practices (Ada & Msughter, 2019).

Secondary schools' heads of schools and the government ought to give health care coverage services, and clinical offices and deal with wiped-out school staff. The

health care coverage service can propel the staff members and lead to powerful teaching and learning (Ada & Msughter, 2019). In addition, the scholars suggest that the government ought to guarantee convenient gratuity payments, medical coverage, annuity and funeral benefits to bereaved families to empower school personnel to do their best. Finally, the government should organise workshops where the school workforce will be provided with timely training to procure awareness, skills and knowledge to make them more operational in their positions (Ada & Msughter, 2019). The scholars strongly conclude that the degree of success of the schooling system relies upon the kind of workforce utilised and how they are effectively overseen.

School-based resources are significant in schools for appropriate instruction and learning to happen appropriately. Mnuabueze (2016) investigated the standard and quality of resource maintenance, utilisation, and accessibility in Education. The scholar explored the availability, accessibility, and utilisation of school-related resources. The researcher noted that these school-related resources incorporate material and human resources for instructional purposes. As the scholar clarifies, the human-based resources are the learners, non-teaching and teaching staff.

On the other hand, material-based resources are financial, teaching materials, and school facilities. These resources are significant in schools for appropriate instruction and learning to happen properly (Mnuabueze, 2016). Therefore, the scholar concludes that school resources ought to be overseen and managed correctly if the objectives and goals of schooling are to be accomplished.

Suleiman, Hanafi and Taslikhan (2018) conducted mixed-method research to investigate the principal's oversight on the relationship between learners' faculty administration staff and academic performance in secondary schools. They found that there are several different school services. Concerning the part of learners' services, say the scholars, they incorporate financial, guidance and counselling, extracurricular, orientation, academic, library, transportation, health, and admission services. Suleiman, Hanafi and Taslikhan (2018) note that all the above-listed services are vital for school success. Letsoalo, Masha and Maoto (2019) led a quantitative cross-sectional investigation in Gauteng Province to determine which of the two sexual orientations, females or males, furnishes the post-secondary educational system with a greater extent of possible Mathematics learners. They found that determinants of learners' mentality towards Mathematics are related to community background, family or home background, teaching, the educators, the environment of the school, and the learners themselves. Next, the researcher introduces the determinant of performance.

Determinant of Performance

Again, the definition of achievement is the ideal or desired result one reaches by studying in a planned manner, with the direction of foreordained objectives and goals (Akay & Karadag, 2019). For that to happen, add the scholars, there are determinant factors that come into play. Vermooten, Malan and Boonzaier (2020) studied basic credits of great educational systems by contrasting 25-educational systems worldwide. The scholars discovered that the quality of the educator is the highly notable determining factor of the efficacy and execution of a system of Education. The scholars concede that

the nature of the educational system cannot surpass the nature of its educators. In accordance with the abovementioned, the scholars guarantee that educator quality is one of the essential main thrusts behind the efficacy and execution of South African Education.

Educator-level determinants incorporate showing inspiration, individual attributes (for example, mental capital, enthusiastic knowledge and work locus of control) and adapting techniques (Vermooten, Malan & Boonzaier, 2020). Vermooten, Malan and Boonzaier (2020) attest that educator-level determinants incorporate showing inspiration, individual attributes (mental capital, enthusiastic knowledge and work locus of control) and adapting techniques. The scholars enlist school-level determinants such as teaching resources, school facilities, workload perceived, school atmosphere, learner-educator relationships and associations. The social setting of the area and parental mentalities constitute community-level determinants of performance (Vermooten et al., 2020). The society-level determinant of performance, concludes the scholars, is the perception of organisational equity.

Predictors of secondary school achievement or graduation are community context, friends, school, family, and individual (Zaff et al., 2017). By and large, learners' characteristics and the background of their families have a much stronger influence over accomplishment or achievement than school factors (Agasisti & Longobardi, 2017). Again, the allocation of resources influences the achievement in Education (BenDavid-Hadar, 2018). Learners and educators portrayed positive self-direction after utilising technology gadgets (Varier et al., 2017). Prior to asking the educator, continue the

scholars, learners showed that their gadget assisted them in looking up concepts they missed. The scholars pointed out that educators depicted models where learners investigated answers alone and worked together to problem-solve.

The use of electronic media can adversely affect academic achievement. Halpern, Pina and Ortega-Gunckel (2020) investigated the effect of learning with YouTube, manually written notes, WhatsApp, and surfing through the Internet on the academic achievement of 12 to 18-year-old learners in Chile. The researchers have found that utilising electronic media in the schoolrooms or at home is identified with the execution of more than one undertaking simultaneously or performing multiple tasks, which inflates learners' disturbance and diminishes their capacity to hold the educational concepts. Moreover, as they present lower abilities to control the impedance of concepts, this would adversely affect their academic achievement (Giunchiglia, Zeni, Gobbi, Bignotti & Bison, 2018a; Halpern et al., 2020). Likewise, the utilisation of electronic media could advance counterproductive learning propensities, for example, "copy and paste" material from the website, shortening the material as they search straightforwardly for answers or synopses of what they must learn, which adversely influences their critical reasoning abilities (Halpern et al., 2020, p. 38).

Informational measures could create a psychological over-burden from various stimuli without having the option to separate what is significant (Halpern et al., 2020; Kolikant & Ma'ayan, 2018). Considering these perspectives, it is conceivable that the utilisation of technology in instructive settings is dislodging conventional resources (Halpern et al., 2020). For example, taking manually written notes, is a practice

demonstrated to improve memory and is a motivating intellectual practice that positively impacts academic achievement (Halpern et al., 2020). Gubbels, Swart and Groen (2020) examined the accessibility of digital resources, learners' utilisation of those resources, and learners' mentalities toward digital resources. They have demonstrated that moderate accessibility and utilisation of digital devices positively correlate to electronically assessed reading achievement in Dutch learners. However, as the scholars point out, unreasonable and overly accessibility and utilisation of digital devices are negatively related to Dutch learners' achievement in electronically evaluated reading.

Learners do not have higher capacities to deal with the material they get from the website. Halpern, Pina and Ortega-Gunckel (2020) exploration left three significant outcomes. First, it was found that many learners simultaneously utilise various gadgets and platforms to learn (Halpern et al., 2020). Second, as the scholars continue, using electronic resources relies upon their skills and enthusiasm to look at and assess data on the web. However, their capacity to control and regulate the utilisation of these ICT resources for learning purposes would be given by their ability to control and regulate the utilisation of these ICT resources (Halpern et al., 2020). Third, the individuals who learn most often with handwritten notes get higher grades, while those who habitually learn with WhatsApp and YouTube get lower grades (Halpern et al., 2020). The scholars emphasise that this is because learners perceive that they do not have higher capacities to deal with the material they get from the website nor the skills to self-manage their utilisation of gadgets when learning. Therefore, one of the fundamental difficulties that learners have today is to expand their ability to manage their work to various stimuli and to figure out

how to choose online resources all the more effectively, which accelerates the learning cycle (Claro, Cabello, San Martín & Nussbaum, 2015; Halpern et al., 2020).

When utilised as a replacement for handwritten notes, digital devices reduce academic achievement (Halpern et al., 2020). However, when utilised as a support, Halpern, Pina and Ortega-Gunckel (2020), state that digital devices positively contribute to academic achievement. Additionally, it appears that in clear cases would, digital devices make the learning process more proficient by assisting learners in raising their interests (Halpern et al., 2020). Hence, emphasise Halpern, Pina and Ortega-Gunckel (2020), the role of educators is significant concerning the in-class material because when learners do not confide in what the educator is conveying or are not inspired by their way of teaching the concept, they incline toward electronic devices as an alternative. In any case, most studies concur that most learners do not have the ability to assess a lot of material found on the web (Coklar et al., 2017; Halpern et al., 2020). That could enlighten, for example, that the utilisation of web searches does not return positive outcomes, nor does the material shared utilising WhatsApp.

The educator quality is viewed as the main school-related achievement factor and can be more remarkable than numerous out-of-school elements. Superville (2017) says stakeholders in Education see a successful educator with solid pedagogical skills. The scholar adds that this incorporates the accompanying: Using applicable educating and learning aids in one's lesson; Utilising an assortment of instructional systems; Being ready to finish the syllabus; The capacity to clarify content plainly and clearly; Making learning charming and fun; Engage in early planning. Accessibility to an effective educator is the

most significant school-related element for better understanding (Superville, 2017). The scholar emphasises that educator quality is the main school-related element and can be more remarkable than numerous out-of-school elements. The scholar further points out that educators are the main school-based elements for learner achievement.

Learners are competent to detect whether their educators are effective (Superville, 2017). The scholar observed that the learners know when the educator cares, prepares for the lesson, and teaches well. On the other hand, when learners are given a whiling-away time to work, they perceive that their time is misused and can lose learning interest (Superville, 2017). In this way, concludes the scholar, numerous learners in Tobago and Trinidad are put in out-of-school classes and that private-lesson culture, an expensive endeavour for guardians and parents, has become common in Tobago Trinidad systems of Education.

Achievement in low-size schools is higher than that in enormous size schools. Orzea and Cocoradă (2017) examined the relationships between the school atmosphere and school achievement in low and medium-sized schools, centrally or non-centrally located. Their study shows that in low-sized schools, learners are happier with school, sense and feel an attachment to it, and their relationships with fellow learners and educators are very close. Educators will generally positively view the school atmosphere in low-sized schools, their capacity to impact school policies and resources, superior schoolroom control, and school guidelines, making it simpler to customise instruction-learning exercises (Orzea & Cocorada, 2017). The scholars point out that achievement in low-size schools is higher than in enormous-size schools. Learners' academic

performance in reading and Mathematics deteriorates as the size of the school rises, and the undesirable impact is more in higher grades (Orzea & Cocorada, 2017). However, scholars Orzea and Cocorada (2017) have concluded that different scholars have discovered no contrasts between learners' achievement in enormous and low size schools.

A school's general financial status, the learner-academic level at the time of admission, and the availability of school-based facilities and school-material resources can improve learner achievement partly and all the more successfully (Guihua & Yangyang, 2020). According to Guihua and Yangyang (2020), the availability of school-related resources mirrors a school's limit to attract, mobilise, and gather resources. Therefore, the school can utilise these resources to improve learner-academic advancement (Guihua & Yangyang, 2020). The scholars conclude that learner-level factors, such as learning propensities and learning background, assume a more significant function in advancing academic achievement. According to Okori and Jerry (2017), when properly utilised, teaching resources facilitate learning, make teaching-learning more meaningful, and increase the capability and competency of educators. Then again, add the scholars, that when teaching resources are not properly used because of the absence of knowledge on the best way to utilise them, the STEM teaching-learning method might be negatively affected. The material resources used in the Sciences will assist in facilitating the teaching-learning of Mathematics if educators as implementers of the educational plan engage in inappropriate use of the resources (Okori & Jerry, 2017).

Observational proof has demonstrated that school factors are strongly correlated with the educational performance of their learners (Su & He, 2020). According to Akay and Karadag (2019), despite the fact that the school-based variables were viewed as having a minimal effect on learners' educational performance during the 1970s, later explorations zeroed in on the effectiveness of the school and demonstrated that schools could make an impact. Physical school-related resources, school discipline, and school atmosphere predict achievement in a significant way (Akay & Karadag, 2019). The scholars note learners who finish tasks given by the educator and study at a school that effectively achieves better tests. School factors can add value which improves learner achievement, paying little heed to the attributes or characteristics of the learner (Laukaityte & Rolfsman, 2020). Based on PISA and TIMSS enormous scope assessment data, past research points out that scholars uncovered that a small number of school-level factors appeared to be related to learner achievement. In top achievers in Nordic countries, continue the scholars, a small number of school-level variables appear to be associated with achievement in PISA Mathematics 2003-2012 tests. The scholars contend that school-level variables appear significant just in Denmark. Generally, a small number of school-level factors appeared to be related to learner achievement (Laukaityte & Rolfsman, 2020).

Incorporating technology into teaching is quickly turning into a normal standard. In Mathematics Education, the imbuement of technology considerably modifies the teaching-learning of Mathematics (Zaenal et al., 2018). The scholars add that affordances of technology permit the increase of new resources to Mathematics content and practice

teaching methods in remarkable ways. Technology gives educators the instrument to associate Mathematics theories with real-life challenges to investigate Mathematics concepts and dissect or analyse circumstances as they solve the problem. According to Zaenal, Anuradha and Roberta (2018), technology can assist learners with discovering new concepts, and educators must plan challenges that surpass just entering figures to develop participation and dialogue among learners. However, schools in the countryside are disadvantaged because they do not have technology accessibility (Zaenal et al., 2018).

Academic achievement of the learner increases with the increase in the educational levels of the guardians or parents and the yearly school expenditure for the learner (Aslan, 2017). Harju-Luukkainen, Vettenranta, Wang and Garvis (2020) explored the relationships between family-related finances and different variables like parents' level of Education, measure of literature at home, parental perspectives towards Mathematics, parents' view of learner's early abilities and learner's future academic performance. They found that household-related background factors have various effects on learners' future performance in Mathematics across Finland. Yıldırım (2019) conducted a multilevel modelling analysis study to examine the direct and aberrant impacts of family financial status through parents' self-confidence and involvement in learners' mathematics learning. The scholar found that school- and home-related factors positively influence learners' Mathematics achievement.

Each educator's chosen teaching methods are a significant factor and determinant of learner achievement and involvement in schoolroom discussions. Beckwitt, Van Camp

and Carter (2015) explored the IB introduction of the Diploma Program (DP) in the United States. Ensuring learners have well-trained educators and administrators who promote coaching, mentoring, supporting, and offering educational resources is essential. Encouraging educator improvement, development, and learning are planned resourcing strategies positively related to International Baccalaureate (IB) exam-scores (Lee et al., 2018). Pendergast, Dole and Rentoule (2014) analysed the discussion of learner experiences in an IBMYP and IBDP Mathematics lesson in an independent school. Their research reveals that each educator's chosen teaching methods are a significant contributing factor and determinant of learner involvement in schoolroom discussion. Therefore, point out the scholars, it is the educator, not the curriculum, which decides a learner's lesson experience, proposing that teaching method workshops must be organised for specific educators for an effective change. The educator and his teaching method are critical in deciding the learner's performance (Pendergast et al., 2014). Lee, Walker and Bryant (2018) emphasise that effective resource allocation is associated with leadership that is most compelling and influential in improving learners' learning outcomes.

Learners are likely to perform better academically when the family gets involved in their education. Skrzypiec, Askell-Williams, Slee and Rudzinski (2014) investigated the well-being of IBMYP learners. They found that successful schoolroom practices depicted by educators include supporting learners with resources, having collaborating staff members, a culture of progress, learner abilities and skills development, and engaging learners. In addition, as the scholars allude, they are ensuring an excellent relationship

with guardians, parents and learners, taking care of learner well-being, and providing a free from any danger learning environment. Letsoalo, Masha and Maoto (2019) conducted a study that determined the gender that attained high performance in Physical Science and Mathematics in secondary schools in South Africa. They found that learners are likely to perform better academically when the family gets involved, when there are adequate teaching-learning resources, when the family has high financial status, and when learners have both parents.

Audio-visual material has a major effect on the lessons in secondary schools. Oviawe and Uddin (2020) studied the impact of audio-visual material as a teaching method for enhancing learners' academic performance in geometry. They found that a lesson enhanced with audio-visual resources extraordinarily improves the learning results of learners in school subjects. Using audio-visual aids improves learners' performance (Oviawe & Uddin, 2020). Therefore, the scholars strongly advise that audio-visual material significantly affects the lessons in secondary schools. Quarcoo-nelson, Buabeng and Osafor (2012) explored the effect of audio and visual resources on senior-secondary school learners' performance in Physics. The scholars detailed that senior secondary school learners trained with audio-visual supported lessons achieve better than those taught with conventional methods.

Generally, disappointments and low achievement in Mathematics are brought about by inadequate teaching and learning climate (Abirin & Obra, 2019). Therefore, conclude the scholars, learners need much inspiration to adapt to Mathematics. Arends and Visser (2019) give experimental proof of how learners' perspectives towards

educators added to their feeling of school belonging and their Mathematics performance. They found that learners' perceptions and attitudes towards educators and their sense of belonging contribute significantly to Mathematics performance. A sound learner-educator relationship plays a critical job in academic achievement and a health perspective of school belonging (Arends & Visser, 2019). The scholar emphasises that the school environment should be overseen in a way that reinforces coaching and mentoring relationships among learners and educators.

Global comparative research should gauge the impacts of after-school lessons on learners' achievement. For example, O'Dwyer, Wang and Shields (2015) investigated educators' utilisation of specific instructional techniques and whether utilisation is related to learner performance. They found that the prevalence of extra after-school lessons for East Asian learners as a major contributor to their excellent performance cannot be denied. Therefore, global comparative research should gauge the impacts of after-school lessons on learners' achievement and separate those impacts from the consequences of formal educational structures of countries (O'Dwyer et al., 2015). Next, the researcher introduces the characteristics of a successful school.

Characteristics of a Successful School

For a school to be successful, the resources and curriculum of the school should be accessible inside and outside of the school to sway the learner's learning, particularly in Mathematics (Fisher & Crawford, 2020). Fisher and Crawford (2020) reiterate that a good curriculum and top-notch pedagogy, primarily focusing on reading and Mathematics, are a total mark of a successful school. A successful school has resources and an

organised network (Fisher & Crawford, 2020). Even though the school-related variables were viewed as having little effect on learners' academic achievement during the 1970s, later explorations zeroing in on school effectiveness demonstrated that schools make a difference (Akay & Karadag, 2019). There is a relationship between school-related resources and learner achievement in China (Guihua & Yangyang, 2020). According to Barnett, Avila and Aklog (2017), a successful school provides staff resources to learners (for example, clinicians, psychologists, social workers, and career-guidance specialists) to help learners tackle difficult subjects like that needed in the IBDP.

A successful school has software school-related resources that give differentiated tasks to learners, contingent upon their degree of comprehension (Fisher & Crawford, 2020). According to Fisher and Crawford (2020), with regard to technology, the successful school gradually engrosss itself in teaching-learning resources to support families, educators, and learners. Access to numerous technology resources can encourage and promote the retention of more mind-boggling measures and advance active learning (Halpern et al., 2020). Likewise, it has been seen that utilising digital resources for learning not only expands learners' interest but also their development and involvement of cross-over skills (Claro, Cabello, San Martín & Nussbaum, 2015; Halpern et al., 2020; Hu, Gong, Lai & Leung, 2018; Zhang, 2015). For example, coordinated effort and self-directed, self-sufficient learning are positively identified with academic achievement (Halpern et al., 2020).

Many learners simultaneously utilise various gadgets and platforms to learn (Halpern et al., 2020). A school that is successful encourages learners to take manually

written notes, a practice that has been demonstrated to improve memory and the nature of material just as motivating intellectual practices through learning procedures that impact academic achievement in a positive way(Costa et al., 2020; Halpern et al., 2020). The individuals who often learn with handwritten notes get higher grades, while those who habitually learn with WhatsApp and YouTube get lower grades (Halpern et al., 2020). The scholars add that digital devices reduce academic achievement when utilised as a replacement for handwritten notes. However, when utilised as a support, emphasise the scholars, that digital devices positively contribute to academic achievement. Successful schools operate digital devices because they can make the learning process more proficient by assisting learners in raising their interests (Halpern et al., 2020).

Successful schools have educators with solid pedagogical skills (Superville, 2017). According to Superville (2017), this incorporates the accompanying: Using applicable educating and learning aids in one's lesson; Utilising an assortment of instructional systems; Being ready to finish the syllabus; The capacity to clarify content plainly and clearly; Making learning charming and fun; Engage in early planning. Accessibility to an effective educator is the most significant school-related element for better learning (Superville, 2017). The scholar adds that educator quality is the main school-related element and can be more remarkable than numerous out-of-school elements. Therefore, educators are the main school-based elements for learner achievement (Superville, 2017).

According to Barnett, Avila and Aklog (2017), a successful school provides facilities to create supportive learner groups that can be continued over the long run. For

instance, when allocating learners to homerooms toward starting their secondary school, a lead educator remains with the learner-group until matriculation (Beckwitt, Van Camp & Carter, 2015). The lead educator would then be able to monitor how each learner gets along academically and socially, with the option of intervening when things are not moving in the right direction. Beckwitt, Van Camp and Carter (2015) explored the IB introduction of the Diploma Program (DP) in the United States. They observed that it is crucial to ensure that learners have well-trained educators and administrators who promote coaching, mentoring, support, and educational resources.

Out-of-school classes and private-lesson culture are common in successful schools (Superville, 2017). According to Barnett, Avila and Aklog (2017), a successful school provides help lessons for learners with special needs. According to Barnett, Avila and Aklog (2017), a successful school puts up help structures (a learning-support department) to give individual social-emotional counsel and academic help. Academic achievement of the learner increases with the increase in the educational levels of the guardians or parents and the yearly school expenditure for the learner (Aslan, 2017). Harju-Luukkainen, Vettenranta, Wang and Garvis (2020) found that household-related background factors affect learners' future performance in Mathematics across Finland.

By and large, learners' characteristics and the background of their families have a much more significant influence over accomplishment or achievement than school factors (Superville, 2017). Learners' perceptions and attitudes towards educators and their feeling of belonging contribute to Mathematics performance (Arends & Visser, 2019). According to Barnett, Avila and Aklog (2017), a successful school promotes a school-

wide message that urges learners to see themselves as talented for performing at elevated levels. According to Barnett, Avila and Aklog (2017), a successful school provides an opportunity for learners' autonomous choice-making through components of the IBDP, for example, CAS, the extended essay, and the theory of knowledge. According to Barnett, Avila and Aklog (2017), a successful school cultivates self-knowledge by offering open doors for learners to reflect on areas of a strong point and embrace territories they might want to improve. According to Barnett, Avila and Aklog (2017), a successful school gives many organised experiences, allowing learners to develop developmentally. For instance, organising the extended essay in IBDP encourages learners to construct a conviction to handle a problematic, long-term exploration.

Low-size school is a characteristic of a successful school. Achievement in low school sizes is higher than in enormous size schools (Orzea & Cocorada, 2017). The scholars add that learners' academic performance in reading and Mathematics deteriorates as the size of the school rises, and the undesirable impact is greater in higher grades. Low-size school's learners are happier with the school (Orzea & Cocorada, 2017). They sense and feel attached to it (Orzea & Cocorada, 2017). Learners' relationships with fellow learners and educators are very close (Orzea & Cocorada, 2017). In low size schools, continues the scholars, educators will generally have a favourable view of the school atmosphere. Their capacity to impact school policies, resources, superior schoolroom control, and school guidelines makes it simpler to customise instruction-learning exercises (Orzea & Cocorada, 2017). However, it is worth noting that

Orzea and Cocoradă (2017) say different scholars have discovered no contrasts between learners' achievement in enormous and low size schools.

A successful school has an excellent learner-educator relationship. Arends and Visser (2019) confirm that the significant job that a sound learner-educator relationship plays from as far as academic achievement and a health perspective of school belonging. The scholars add that the environment of the school should be overseen in a way that considers coaching and mentoring relationship among learners and educators to be reinforced. According to Barnett, Avila and Aklog (2017), a successful school works to establish a school climate that challenges learners but support and encourage them at the same time. According to Barnett, Avila and Aklog (2017), offering a diversity of choices for IBDP learners, from taking one class to doing the full IBDP.

A successful school encourages learners to follow their interests and promote learning. According to Barnett, Avila and Aklog (2017), a successful school encourages learners to participate in activities and clubs that strengthen their relationship with the school and among themselves. A successful school allows learners to work in groups, encouraging connection and community (Barnett, Avila & Aklog, 2017). A successful school reiterates Barnett, Avila and Aklog (2017), encouraging learners to follow their interests and promote learning more about themselves through service (CAS), activities, creativity, sports, and arts. A successful school, conclude Barnett, Avila and Aklog (2017), encourages learners to take on positions of authority in learner government, sports, clubs, or different undertakings, permitting them to build self-confidence in various roles and circumstances. It is one of the objectives of every school to be successful in producing

good results in learner achievement. Next, the researcher introduces effective teaching in schools.

Effective teaching in Schools

Educator effectiveness is not the main or only supporter of learner life and academic accomplishment. According to Williams, Sullivan and Kohn (2012), effective is a subtle concept. The word describes an educator's worth and ties straightforwardly with being fruitful in schoolroom-teaching (Superville, 2017). Superville (2017) adds that successfulness and Effectiveness are equivalent in that they demonstrate accomplishing wanted outcomes. It is significant to note that educator effectiveness is not the main or only supporter of learner life and academic accomplishment (Superville, 2017). The scholar points out that there are numerous different components associated with the educational achievement process. According to Superville (2017), effective educators are depicted as individuals who have solid psychological abilities, are subject trained professionals, and can change their teaching methods to address the issues of their learners.

Effective teaching makes plausible plans and decisions that augment learning opportunities for learners. Superville (2017, p. 53) characterises effective teaching as teaching that encompasses the capacity to give guidance that encourages learners to build up understandings, skills, and knowledge proposed by educational programme objectives. The scholar continues to explain effective teaching to creates a teaching atmosphere that influences learners to develop good attitudes toward themselves and school. Effective teaching changes instruction, adds the scholar, so all learners learn,

regardless of their ethnicities, abilities, or attributes. The scholar says effective teaching deals with schoolroom management, so learners constantly learn. The scholar clarifies that effective teaching makes plausible plans and decisions that augment learning opportunities for learners. The scholar lastly points to the fact that effective teaching reacts to curricula amendments so that the new curricula expectations are entirely met.

The schoolroom learning community is not linear and not static. Kaur, Tay, Toh, Leong and Lee (2018) explored the school Mathematics educational plan endorsed by experienced educators in secondary schools in Singapore. They found that points of view of the teaching of Mathematics vary from western and eastern viewpoints. Two essential polarities that exist between the points of view of the west and east (Leung, 2001) are (i) the meaningful learning against rote learning and (ii) the process against product learning polarity (Kaur et al., 2018). Schoolroom instruction is mind-boggling (Anthony & Walshaw, 2009), and the schoolroom learning community is not linear or static (Kaur et al., 2018).

In light of their exploration, Kaur, Tay, Toh, Leong & Lee (2018, p. 107) they offer standards of successful teaching method, among which are (i) representations and devices that help learners' reasoning; (ii) mathematical practices that impact how learners come to see, create, utilise and make-sense of Mathematics; (iii) mathematical correspondence with attention on mathematical arguments; and (iv) orchestrating Mathematics learning experiences. Instruction that does not have genuineness and achievement-oriented instruction that makes regularizing correlations with others will create low inspiration, a feeling of disappointment, and an impeding mindset for learning

(Yi & Lee, 2017). The objective of instruction is to help a learner to learn (Yi & Lee, 2017). Next, the researcher enlists library databases accessed and search engines used.

Library Databases accessed and Search Engines used

The following academic search engines were used as great resource providers for the literature review of the current study. The Research Gate offered access to 135 million publications; Microsoft Academic Search provided access to 38 million. Databases and archives consulted are: The Library of Congress have many archives and documents available; The British Library catalogues with a wealth of resources. Books and Journals consulted are: The Google Scholar is the biggest academic database and search engine, was also consulted to find only scholarly resources; The Google Books has world's books indexes; The Science Direct has about 460 million scientific material that includes publications; The Open Library has open e-books and other excellent open and free resources; The Education Resources Information Center (ERIC) with educational literature collection was consulted; The African Journals Online (AJOL) has scholarly journals published in Africa, was also consulted.

Tools like EBSCO host and ProQuest were very helpful in this literature review. These tools were accessed in the Unicaf University online library and the University of South Africa (UNISA) online library. In addition, the International Baccalaureate Organisation website provided a wealth of some grey literature on research conducted in the current study area. The YouTube videos were also helpful as they showed presentations of a wide range of scholars in seminars, workshops, solo events, and many other settings. The search terms that were used were 'availability of school-based

resources', 'availability of school-related resources', 'accessibility of school-based resources', 'accessibility of school-related resources', utilisation of school-based resources', 'utilisation of school-related resources', and changing from UK English terms to US English terms like utilisation and utilization.

Other search terms that were used were 'International Baccalaureate Diploma Mathematics school-based resources', 'International Baccalaureate Diploma Mathematics school-related resources', 'IB Diploma Mathematics Analysis and Approaches school-related resources', 'IB Diploma Mathematics Analysis and Approaches school-based resources', 'Mathematics instructional resources', 'Mathematics school-related resources', 'Mathematics school-based resources', IB Diploma Mathematics resources', 'IB Diploma Mathematics instructional resources', the search will wide at first, and narrowed down to the last five years and peer-reviewed publications. Other search terms that were used were 'school-related resources and determinants of achievement', 'school-based resources and determinants of achievement', 'school-related resources and determinants of achievement in Mathematics', 'determinants of performance in schools'. 'determinants of performance in Mathematics', 'determinants of performance in IB Diploma Mathematics', 'determinants of performance in IB Diploma Mathematics AA', and the performance and achievement terms were also used interchangeably. In every search phrase mentioned above, the researcher would add the terms 'Africa' then 'South Africa' or 'Asia-Pacific' then 'Singapore' to limit the scope when it was too broad. These search terms provided valuable resources for the current literature review (please see the literature matrix of the

recent study in Appendix S). Next, the researcher presents the theoretical framework of the current study.

Theoretical Framework of the Study

The Hierarchy of Needs theory of Abraham H. Maslow (*figure* 1) and the Theory of Engagement of Greg Kearsley and Ben Shneiderman are the anchor of the theoretical framework of the current study.

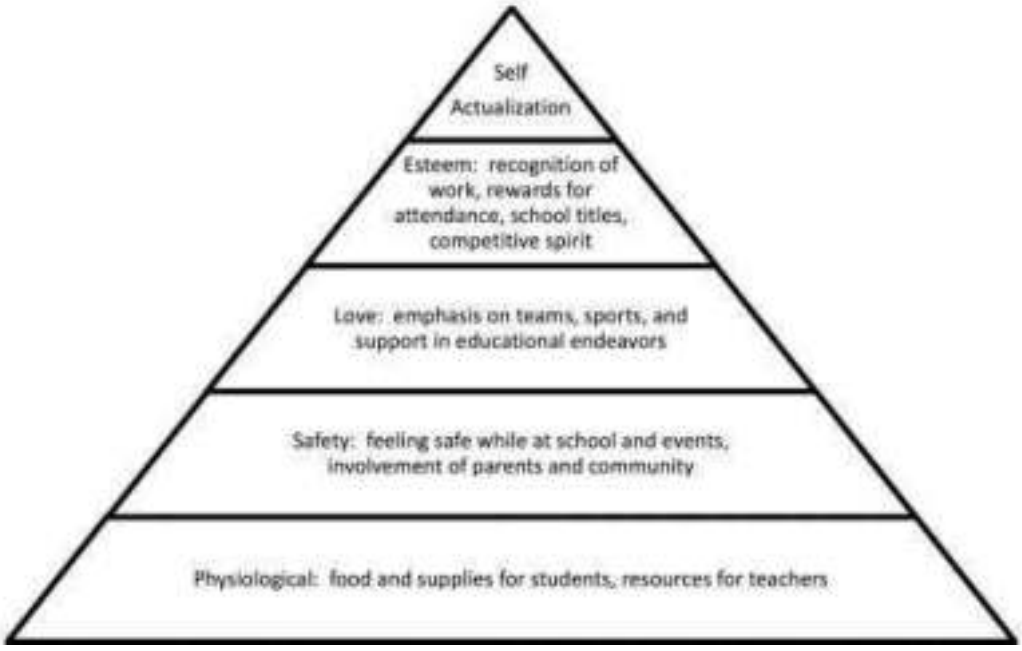

Figure 1 Needs Hierarchy of Maslow in relation to teaching-learning support in Schools (A)

Needs Hierarchy of Maslow in relation to teaching-learning support in Schools (A)

Notes: Needs Hierarchy of Maslow adapted from Maslow (1943, p. 372) and Fisher and Crawford, (2020, p. 13) in relation to teaching-learning support in Schools.

The current study comparatively investigates school-related resources as determinants of Mathematics achievement in IBDP learners doing Mathematics AA

courses in South Africa and Singapore. School-related resources are physiological needs at the bottom stage of Abraham H. Maslow's hierarchy of needs theory (see *figure* 1). Abraham H. Maslow constructed a hierarchical need-chain of humans which has been helpful since its development and can still be used today. The application of the theory is seen from a range of scholarly work in different spun of time, such as assisting underachieving schools (Fisher & Crawford, 2020), the needs of Mathematics educators (Fisher & Royster, 2016), educator's needs for their retention (Weller, 1982), studying knowledge-retention of learners in advanced education (Brookman, 1989), sustainability and stabilisation of COVID-19 community path forward (Ryan, Coppola, Canyon, Brickhouse, Swienton, 2020), commercial planning on savings goals and behaviours (Lee & Hanna, 2015), the farming rationale (Liu & Wu, 2015), and religious conviction (Balraj, 2017).

The hierarchical needs of Maslow are comprised of five phases, and each stage relies on the earlier stage's fulfilment (Balraj, 2017; Fisher & Crawford, 2020; Maslow, 1943; Ryan et al., 2020). The initial phase of the pyramid of Maslow is the physiological phase and encompasses the necessities of people to stay alive. People should initially have rest, sleep, shelter, water, and food before feeling loved or esteem (Fisher & Crawford, 2020). The current study is anchored and informed by the first stage of the needs hierarchy pyramid by Maslow, whereby the physiological needs explored concerning achievement in Mathematics are school-related resources.

While the physiological needs phase of Maslow's pyramid is the school-related resources in the current study, the theoretical framework does not detail how learners

engage with these resources to enhance learning. The shortfall of Maslow's hierarchy of needs necessitated Greg Kearsley's Theory of Engagement. The engagement theory states that, for collaboration, engagement, and participation in a schoolroom for effective learning, learners should be wholly occupied or engaged with their coursework through available, accessible, and usable school-related resources. The current research explores the effect availability, accessibility, and utilisation of school-related resources have in schoolroom collaboration, engagement, and participation as determinants of Mathematics achievement. Therefore, this study's second theory used as a theoretical framework is Greg Kearsley's Theory of Engagement. Engagement learning theory was introduced by Kearsley and Shneiderman (1998, p. 23) as a model for learning in a technologically-centred environment that synthesises various works from learning theories of the past.

The application of the theory is seen from a range of scholarly work in different spun of time, such as the study on academic views and online best practices to survey experiences for consumers (Mollen & Wilson, 2010), a study that investigated web-based learning experiences for postgraduates and undergraduates learners (O'Shea, Stone, & Delahunty, 2015), an exploration that gave critical understanding into variables that learners found when engaged in enormous scope online open-courses (Hew, Qiao, & Tang, 2018), and an exploration that endeavoured to improve instruction quality through audio-visual resources supported by social-media to teach reading-comprehension (Olagbaju & Popoola, 2020). The main principle for Greg Kearsley's theory is that learners should be occupied entirely or engaged with their course work for effective

learning (Kearsley & Shneiderman, 1998). The theory places three essential means for achieving engagement: an accentuation on collaborative determinations in learning exercises through interactions with other learners or materials, doing tasks that are project-based, and doing some work that is non-academically focused (Kearsley & Shneiderman, 1998).

The scholars proposed that these three strategies bring authentic, meaningful, and innovative learning. Kearsley's engagement theory of learning states that every learner's activity includes dynamic mental processes, for example, interaction, creative thinking, evaluation, and decision making (Kearsley & Shneiderman, 1998; Olagbaju & Popoola, 2020). It further expresses that if the environment is conducive for learning, learners' motivation to learn would be intrinsically (Olagbaju & Popoola, 2020). Constructivism and learner-centeredness anchor Greg's engagement theory of learning (Olagbaju & Popoola, 2020). The theory has been essentially used in all fields to test the working and non-working parts of the theory (Olagbaju & Popoola, 2020). Standards of engagement learning theory have good results in project-based learning, with collaborative activities that focus on form activities (Olagbaju & Popoola, 2020). The theory gives a solid framework to the current research exploring possibilities of good academic performance through availability, accessibility, and utilisation of school-related resources through schoolroom collaboration, engagement, and participation.

Mathematics Achievement

The definition of the word achievement is the ideal or desired result one reaches by studying in a manner that is planned, with the direction of foreordained objectives and

goals (Akay & Karadag, 2019). Learners' perceptions and attitudes towards educators and their feeling of belonging contribute to Mathematics performance (Arends & Visser, 2019). School factors can add value which improves learner achievement, paying little heed to the attributes or characteristics of the learner (Laukaityte & Rolfsman, 2020). Based on PISA and TIMSS enormous scope assessment data, past research uncovered that a small number of school-level factors appeared to be related to learner achievement (Laukaityte & Rolfsman, 2020). No school-level factors in Sweden were significantly found to effectively correspond to Mathematics achievement in TIMSS (Laukaityte & Rolfsman, 2020). In top achievers in Nordic countries, a small number of school-level variables appear to be related to achievement in PISA Mathematics 2003-2012 tests. School-level variables appear to be of significance just in Denmark (Laukaityte & Rolfsman, 2020).

Nations over the Asia-Pacific locale have exhibited significant achievement in global academic tests. Again, Vermooten, Malan and Boonzaier (2020) cite the Global Competitiveness Index Report 2017 – 2018 that South Africa was positioned 114th out of 124 countries in a study that positioned the nature of 124 countries' education systems. The result is in line with other international tests between 2002 and 2016. For example, the Trends in International Mathematics and Science Study, and Progress in International Reading Literacy Study, have reliably announced comparative degrees of educational accomplishment in South Africa (Vermooten et al., 2020). In addition, countries over the Asia-Pacific locale have exhibited rehashed achievement in global academic tests (Wright et al., 2016). Most significantly, the 2012 Program for International Student Assessment (PISA) outcomes uncovered that the best seven achievers for 15-year-olds as to mean

scores for Mathematics were entirely sited in East Asia, a sign of outstanding achievement for the Asia-Pacific countries (Wright et al., 2016).

The Mathematics studies in South Africa and Singapore were conducted in grades 9 and 8, respectively, and in grades 5 in South Africa and 4 in Singapore (Mullis, Martin, Foy, Kelly & Fishbein, 2020). South Africa got position 55 out of 58 countries in grade 5 and 38 out of 39 countries in grade 9 (Mullis, Martin, Foy, Kelly, et al., 2020). In contrast, Singapore got position one out of 58 countries in grade 4 and one out of 39 countries in grade 8 (Mullis, Martin, Foy, Kelly, et al., 2020). This research focuses on advanced learners doing IB Diploma Mathematics Analysis and Approaches courses in South Africa and Singapore for original contribution to knowledge. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. This study is not comparatively investigating school-related resources as determinants of Mathematics achievement of learners doing any school programmes other than the IBDP Mathematics AA course in South Africa and Singapore.

Technology devices can improve achievement in learners when appropriately used and yield adverse outcomes when improperly utilised. According to Varier, Dumke, Abrams, Conklin, Barnes and Hoover (2017), using computers improves learner engagement, enthusiasm, and performance. For example, learners in a Mathematics schoolroom who create and record video scripts about polynomials improve their Mathematics performance (Varier et al., 2017). In addition, the flexibility to finish assignments during spare time at school, type instead of writing, and submitting tasks

online expands learner efficiency and reflects a more substantial commitment and engagement degree (Varier et al., 2017). Varier and Friends (2017) say that secondary school learners articulated that if they had leisure time, they could pull their digital devices up and do homework rather than merely staying there doing nothing, and that made them more efficient.

Learners prefer writing paper-based Mathematics tests over those taken on digital devices since they were uncertain whether the gadget would dependably record answers (Varier et al., 2017). In addition, learners complain about the absence of keyboard and keypad limitation capacities in tablet gadgets, making writing Mathematics tests that require working difficult and inconvenient (Varier et al., 2017). For learners to perform higher in Mathematics, they need formative assessment practices related to improved learner performance (Varier et al., 2017). The current study is anchored and informed by two theories, the first being the first stage of the needs hierarchy pyramid of Maslow, whereby the physiological needs explored concerning achievement in Mathematics are school-related resources. The second is Greg Kearsley's Theory of Engagement which gives a solid framework to the current research exploring possibilities of good academic performance through availability, accessibility, and utilisation of school-related resources through schoolroom collaboration, engagement, and participation.

Developments and innovations in digital gadgets and infrastructure can conceivably meet the Mathematics learning needs of the 21st century (Varier et al., 2017). According to Halpern, Pina and Ortega-Gunckel (2020), past investigations have demonstrated that utilising digital resources for learning purposes can influence academic

achievement in two ways. First, access to numerous technology resources can encourage and promote the retention of more mind-boggling measures and advance active learning (Halpern et al., 2020). Second, the researchers add that it has been seen that utilising digital resources for understanding expands learners' interest and their development and involvement of cross-over skills. For example, coordinated effort and self-directed self-sufficient learning are positively identified with academic achievement (Claro et al., 2015; Halpern et al., 2020; Hu et al., 2018; Zhang, 2015). Next, the researcher discusses the influence stakeholders can make on Mathematics performance.

Household-related background factors can have various effects on a learner's future performance in Mathematics. According to Superville (2017), Stakeholders in education see a successful educator with solid pedagogical skills. The scholar says this incorporates the accompanying: Using applicable educating and learning aids in one’s lesson; Utilising an assortment of instructional systems; Being ready to finish the syllabus; The capacity to clarify content plainly and clearly; Make learning charming and fun; Engage in early planning. Predictors of secondary school achievement or graduation are community context, friends, school, family, and individual (Zaff et al., 2017). They found that household-related background factors have various effects on learner's future performance in Mathematics across Finland (Harju-Luukkainen et al., 2020). The school-related factor is by all accounts more significant in Turkey, as for learners' Mathematics achievement (Yıldırım, 2019). In Caygill, Lang and Cowles' (2010) study, they found that all learners going to non-public schools had administrators who detailed that resource

deficiencies had a negligible effect on Mathematics teaching and learning. Next, the researcher discusses educators as school-based resources.

Educators are the main school-based elements for learner achievement. Accessibility to an effective educator is the most significant school-related element for better learning (Superville, 2017). The educator quality is the main school-related element and can be more remarkable than numerous out-of-school elements (Superville, 2017). Learners are competent to detect whether their educators are effective (Superville, 2017). The learners know when the educator cares, prepares for the lesson, and teaches well (Superville, 2017). When learners are given a whiling-away time work, they perceive that their time is misused and can lose learning interest (Superville, 2017). As a result, Superville (2017) numerous learners in Tobago and Trinidad are in out-of-school classes. That private-lesson culture, an expensive endeavour for guardians and parents, has become common in Tobago and Trinidad systems of education (Superville, 2017). Next, the researcher discusses integrating ICT school-based resources in the teaching-learning process.

For good achievement in Mathematics to be realised, the integration of digital resources or ICT in the teaching-learning of Mathematics in Singapore, Norway, Netherlands, Germany, and Australia is a priority (Costa et al., 2020; Drossel et al., 2017; Gain & Ancho, 2019; Stohlmann & Acquah, 2019). Successful implementation of ICT is an essential teaching-learning process that depends on a school IT material (Eickelmann, Gerick & Koop, 2017). Lacking questionable or antiquated IT material, then again, is viewed as an impediment to the possible utilisation of ICT for teaching (Eickelmann et al.,

2017). In several countries, the IT material of schools has observably improved (Eickelmann et al., 2017; Fraillon et al., 2014). Be that as it may, significant contrasts exist concerning the accessibility of PC based resources (Eickelmann et al., 2017; Fraillon et al., 2014). For example, on average, in the EU, researchers found that five learners share one PC (Eickelmann et al., 2017). However, the current study focuses on IBDP Mathematics AA learners in South Africa and Singapore. Next, the researcher discusses the extent to which PCs can influence learning in schools.

A global contrast shows that two-thirds of learners in secondary schools are not or barely influenced by a need or deficiency of PCs utilised for teaching-learning purposes. They are also unaffected by a lack or poor quality of Internet availability (Eickelmann et al., 2017). Results from the IEA investigation of TIMSS 2003 indicated that performance in Mathematics in all participating countries was positively related to the utilisation of PCs both at home and at school by learners (Eickelmann et al., 2017). However, learners' performance utilising PCs at home is not higher in each nation. Some countries had no significant difference, while others had a significant difference when the learners' families' financial status is controlled (Eickelmann et al., 2017). Research revealed that a more continuous and frequent ICT utilisation at school correlates with lower performance (Eickelmann et al., 2017). Schools utilise ICT tools to help low-performing Mathematics learners (Eickelmann et al., 2017). Factors that influence Mathematics achievement and capability orientated utilisation of PCs in Mathematics schoolroom teaching-learning practices are educators’ competencies and educator-education level (Eickelmann et al., 2017). Next, the ICT and PCs discussion continues.

There are no detected negative impacts of the utilisation of PCs for the school teaching of Mathematics on learners' performance in Singapore. Eickelmann, Gerick and Koop (2017) warn that usability and suitable quality digital devices for teaching Mathematics are essential. Considering teaching-learning of Mathematics, ICT devices that are Mathematics specific, for example, handheld devices utilising subject-specific programming or graphics display calculators (GDCs), removes the requirement for desktop computers in the schoolroom, specifically if they are not promptly accessible in the schoolroom (Eickelmann et al., 2017). Therefore, there is no detected negative impacts of the utilisation of PCs for the school teaching of Mathematics on learners' performance in Singapore, Norway, and Australia (Eickelmann et al., 2017). From an instructive perspective, allude the scholars, it must be added that the recurrence of PC utilisation is an inadequate pointer of acquisition of competence. From a mathematics-related perspective, the Mathematics abilities acquisition relies upon how PCs are utilised (Eickelmann et al., 2017). Next, the researcher discusses how technology resources can assist learners in schoolrooms.

Incorporating technology into teaching quickly becomes a standard (Zaenal et al., 2018). In Mathematics Education, the imbuement of technology considerably modifies the teaching and learning of Mathematics (Zaenal et al., 2018). Affordances of technology permit increased new resources to Mathematics content and practice teaching methods in distinctive ways (Zaenal et al., 2018). Technology gives educators the instrument to associate Mathematics theories with real-life challenges so their learners can investigate Mathematics concepts and dissect or analyse circumstances as they solve the problem

(Zaenal et al., 2018). Various explorations recommend the requirement to observe learners' attitudes concerning Mathematics and their learning with digital devices (Zaenal et al., 2018). Monitoring learners' attitudes toward Mathematics when digital devices are initially presented in the Mathematics schoolroom is highly recommended (Zaenal et al., 2018).

Technology can assist learners with discovering new concepts, and educators must plan challenges that go past just entering figures to develop participation and dialogue among learners (Zaenal et al., 2018). Digital devices give learners a more vivid schoolroom experience with realistic and graphical energizers, including hand-eye coordination actions like utilising drag-dropping objects, touch-screen, or squeezing for zoom-out and zoom-in instances (Zaenal et al., 2018). Even though the incorporation of technology into programmes of education offers numerous paths for educators to engage with learners, we need to focus on learners' viewpoint toward technology utilisation (Zaenal et al., 2018). It is worth noting that male learners view PC-based Mathematics lessons more positively than female learners (Zaenal et al., 2018). Schools in the countryside are disadvantaged because they do not have technology accessibility (Zaenal et al., 2018). Accessibility to electronic devices may add to contrasts in mentalities toward electronic devices in Mathematics (Zaenal et al., 2018).

Schools with a more significant part of learners from middle-upper financial status can carry electronic gadgets to support their teaching-learning processes (Zaenal et al., 2018). This situation might be distinctive for schools where most learners are from a middle-lower financial status. They might not have straightforward accessibility to

electronic devices and cannot bear the cost of individual gadgets (Zaenal et al., 2018). On the other hand, electronic devices motivate learners to partake in schoolroom lessons utilising technological devices, thus prompting them to acquire augmented self-confidence in Mathematics (Costa et al., 2020; Zaenal et al., 2018). Next, the researcher discusses the benefits of using individualised technology.

Utilising one's electronic gadgets brings a feeling of having a place and closeness. Learners in the Zaenal, Anuradha and Roberta (2018) exploration demonstrated good sentiments about the utilisation of electronic devices in Mathematics and can construe that they had improved enthusiasm, and were technologically confident, which are significant aspects learners in Mathematics learning with electronic devices. If learners have positive mentalities in a PC-assisted Mathematics environment, they will be convinced that technological devices enhance their learning improvement (Zaenal et al., 2018). Furthermore, learners who learn utilising individualised technology-based gadgets express inspirational mentalities toward the utilisation of Mathematics technology (Zaenal et al., 2018).

Zaenal, Anuradha and Roberta (2018) investigation affirms that one-to-one learning utilising one's electronic gadgets rather than learning in groups that share an electronic device among individuals from the group affects learners' general involvement. Utilising one's electronic gadgets brings a feeling of having a place and closeness while interacting with the electronic device, contrasting with uncertainty and absence of possession when utilising another person's electronic gadget (Zaenal et al., 2018; Gain & Ancho, 2019). Furthermore, discoveries have uncovered that group learning

encourages cooperative learning (Zaenal et al., 2018). However, the scholars conclude that having one electronic gadget among the group confines how learners can participate with the electronic gadget. Next, the researcher discusses performance in IB programmes like the IBPYP and IBMYP.

Performance in IBPYP Mathematics in the USA depends on the school's location (Hemelt, 2015). Storz and Hoffman (2018) explored implementing a change of curriculum from an educator-learner point of view. They found no more robust Mathematics and reading improvements for IBMYP learners in an urban state-funded school, yet educators express good feelings about learner performance and educator teaching methods. The International Schools' Assessment (ISA) surveys learner achievement in 3-10 grades over four spaces: Expository Writing, Narrative Writing, Reading, and Math Literacy (Tan & Bibby, 2012a). Overall, despite some territorial contrasts, the performance of IBPYP and IBMYP learners on the ISA showed that they outflanked their non-IB colleagues over each of the four-test areas in a larger part of the grade levels, with the most grounded impacts noted in tenth grade (Tan & Bibby, 2012a).

The IBPYP and IBMYP learners beat their non-IB colleagues with a generally enormous edge in Africa, the Americas, and Europe for most comparative groups (Tan & Bibby, 2012a). Moreover, there was proof that IBPYP and IBMYP learners were bound to outflank their peers with just a solitary program executed (Tan & Bibby, 2012a). Factors affecting learner achievement to a certain degree are capabilities, qualifications, the number of educators in an institution, and any discriminatory admission policies and funding sources (Tan & Bibby, 2012a). However, the current study is not comparatively

investigating school-related resources as determinants of Mathematics achievement among IBPYP learners. Instead, the study comparatively investigates school-related resources as determinants of Mathematics achievement among IBDP learners doing Mathematics AA courses in South Africa and Singapore. Next, the researcher discusses achievement in IBMYP compared to non-IBMYP learners.

Achievement in Mathematics was a little but significantly greater for IBMYP learners than in comparative non-IBMYP schools. Until 2010, according to Tan and Bibby (2012), their study was the first global investigation analysing how IB learners achieve

on the ISA when contrasted with their non-IB counterparts across Africa, Americas, Europe, Oceania, and Asia. IB learners' Grade 9-10 ISA scores in Mathematics are fundamentally superior to most, if not all, OECD contestant and partner nations' mean scores in similar evaluation parts (Tan & Bibby, 2012a). There is inadequate proof to propose that schools approved by the International Baccalaureate Organisation for a more extended timeframe produce better learner results (Tan & Bibby, 2012a).

IB educators have promoted the reformist academic philosophy of the IB as a standard method to encourage the advancement of 21st-century aptitudes. Wade (2011) investigated parent and learner ratings of school atmosphere and the relation between learner achievement and learner engagement in two sets of schools. The scholar found that achievement in Mathematics was a little but significantly greater for IBMYP learners than in comparative non-IBMYP schools. IB educators have promoted the reformist academic philosophy of the IB as a standard method to encourage the advancement of 21st-century aptitudes while likewise giving adequate heaviness to the learning of

essential school content (Wright et al., 2016). However, the current study is not comparatively investigating school-related resources as determinants of Mathematics achievement among IBMYP learners. Instead, the study comparatively investigates school-related resources as determinants of Mathematics achievement among IBDP learners doing Mathematics AA courses in South Africa and Singapore.

Resources creatively used in teaching STEM builds the likelihood that STEM learners will retain and increase the achievement abilities that need to be developed (Okori & Jerry, 2017). When properly utilised, add the scholars, teaching resources facilitate learning, make teaching-learning more meaningful, and advance the capability and competency of the educators. Then again, when teaching resources are not adequately used because of an absence of knowledge on the best way to utilise them, the STEM teaching-learning method might be negatively influenced (Okori & Jerry, 2017). Teaching-learning resources, noted the scholars, are misused when they are ineffectively placed into utilisation to accomplish already determined short term goals.

Inappropriately used teaching-learning resources could prompt misguided judgment of thoughts, create misunderstanding and make a learner disdain the subject not recover the inspiration that stimulates his curiosity on the subject matter (Okori & Jerry, 2017; Stohlmann & Acquah, 2019). Moreover, inappropriately utilised resources exuding from lacking skills could result in poor STEM learners and educators (Okori & Jerry, 2017). The material resources used in the Sciences, conclude the scholars, would assist in facilitating the teaching-learning of Mathematics if educators as implementers of the educational plan engage inappropriate use of the resources.

Using Audio-visual teaching-learning materials as a teaching-learning technique in higher learning positively affected learners' performance and interest in Mathematics (Oviawe & Uddin, 2020). The scholars point out a significant impact of the audio-visual teaching-learning approach on learners' academic performance and interest in Mathematics. The scholars presume that audio-visual teaching-learning methodology is a superior teaching-learning approach than the educator-centred methodology for schoolroom teaching. Teaching-learning techniques in all subjects have an extensive positive or negative impact on learners' academic performance and curiosity on learners for the most part (Oviawe & Uddin, 2020). In this way, as the scholars point out, the utilisation of audio-visual materials in Mathematics could advance learners' performance and curiosity. Educators should utilise audio-visual methodology in teaching Mathematics to increase learners' academic performance and interest (Oviawe & Uddin, 2020). Educators already in the teaching profession should be re-trained through on-job training, clarify the scholars, for example, workshops, seminars and conferences to bring their knowledge up-to-date.

The conventional teaching approach utilised to impart knowledge in the past was adequate (Oviawe & Uddin, 2020). However, argue the scholars, the brains of the present age learners differ from past learners. The scholars suggest that the current learners are scientifically educated and use new digital devices to cultivate their insight. Consequently, reiterate the researchers, the advancement of schooling and instructive innovation ought to follow the movement of time. Hence this calls for new creative instructional methodologies that could address the necessities of the present learners (Oviawe &

Uddin, 2020). The scholars add that this could be in the teaching-learning resources utilised for teaching and learning. Teaching-learning resources help exchange facts from one individual to the next (Oviawe & Uddin, 2020). Teaching-learning resources are essential for the teaching technique since they supplement the instructional conveyance approach implemented by the educator (Oviawe & Uddin, 2020).

A lesson enhanced with audio-visual resources extraordinarily improves the learning results of learners in school subjects (Oviawe & Uddin, 2020). The use of audio-visual aids improves learners' performance and significantly affects the lessons in secondary schools (Oviawe & Uddin, 2020). Quarcoo-nelson, Buabeng and Osafor (2012) explored the effect of audio-visual resources on senior secondary school learners' performance in Physics. The scholars detailed that old secondary school learners trained with audio-visual supported lessons achieve better than conventional methods.

Learners must have an uplifting demeanour and delight in learning Mathematics (Costa et al., 2020). According to Costa, Caldeira, Lopes and Figueiredo (2020), Mathematics educators are continually searching for plausible answers for such questions: How can Mathematics educators make learners responsive and more receptive in the schoolroom? Do the learners, as of now, have an inspirational disposition for learning Mathematics? Learners can learn by observing their peers' recorded videos (Costa et al., 2020). The objectives of these videos are unambiguous and resolve short Mathematic problems or have a suggested Mathematics topic (Costa et al., 2020). The learners need to make the video briefly and have limited resources. It is a low-cost instructive video (Costa et al., 2020).

Learning might include understanding non-concrete concepts, behaviour development fitting to explicit circumstances, debating ideas, reasoning, acknowledgement, methods and approaches, recalling concepts, and understanding proofs (Costa et al., 2020). With the rise of the Internet, the utilisation of video recordings in a school setting has unlocked up a broad scope of changes, diminishing the expenses of the teaching-learning practice and contributes to increasing learner inspiration for learning (Costa et al., 2020). Numerous research work presents encounters, including utilising video recordings in a schoolroom climate (Costa et al., 2020). Notwithstanding, educators plan these video recordings. In Costa, Caldeira, Lopes and Figueiredo (2020) work, the goal is for the learners to do it, and they plan the video recordings.

Learners learn more and better when effectively included, engaging the significant function of active learning (Costa et al., 2020). According to Costa, Caldeira, Lopes and Figueiredo (2020): Concepts coordinated and organised by individual means that make sense is bound to be recalled, learned, and utilised; To learn well, learners require feedback-comment about what they learnt; Collaboration among learners and educators is the most impressive features in advancing learning, and learners' collaboration is another; Learners ought to have an exclusive expectation of the subject; Consequently they ought to know the particular objectives and broad objectives of the subject from the earliest starting point; Educators ought to build the curiosity of learners because of the way that it is alterable and is one of the fundamental drivers of failures; The manner by which educators deliver the concepts is a significant component for the learning cycle since learners have different abilities and methods of learning.

All the more as of late, digital devices advance the way toward learning in accordance with a portion of these variables, in particular the significance of learners' communication with the school they are in, feedback, joyful learning, to name but a few (Costa et al., 2020). Along these lines, utilisation of video recordings in a learning setting is not just legitimised but uncovers significant benefits, explaining a portion of the standards referenced above (Costa et al., 2020). A flipped schoolroom application is a handy tool in the teaching-learning process (Costa et al., 2020). The flipped schoolroom model depends on the possibility that conventional teaching-learning practice is modified as what is ordinarily done in the schoolroom is flipped or exchanged with what is typically done by the learners out of the schoolroom (Costa et al., 2020).

In that case, learners are welcome to study publications, watch video recordings, and read materials that permit them to take in a schoolroom setting a more energetic discussion, reflection and breakdown of the subject studied (Costa et al., 2020). Video recordings permit learners to learn at their speed (Costa et al., 2020). Video recordings urge learners to effectively participate in the teaching-learning practice (Costa et al., 2020). Video recordings open up real schoolroom time for more active, creative, and effective learning exercises (Costa et al., 2020). Educators get extended chances to collaborate with and evaluate learners' learning with video recordings, and learners assume control and accountability for their learning (Costa et al., 2020; Nouri, 2016). A few research work uncovered that flipped schoolroom is prominently recognized in advanced education (Costa et al., 2020). Flipped schoolrooms encourage learners' participation in schoolrooms because academics inform and rationalise the flipped

schoolroom model's motivation (Betihavas, Bridgman, Kornhaber, Cross, 2016; Costa et al., 2020).

Digital devices have significantly transformed teaching-learning (Costa et al., 2020). Working, communicating, studying, learning, and teaching have changed, and the utilisation of video specifically added to this change (Costa et al., 2020). According to Brame (2016) and Costa, Caldeira, Lopes and Figueiredo (2020), utilisation of video-recordings effectively as a teaching-learning resource is fortified when educators think about three components: How to encourage active learning from the video-recording; How to amplify learner commitment with the video-recording; How to oversee psychological heap of the video-recording. In addition, a few research works have perceived the significance of video as a learning instrument (Costa et al., 2020).

The inspiration and consideration of the learners, because of the chance of these bids to audio-visual content and to join them with other learning materials, for example, messages, groups, surveys, and so forth, increase impressively (Costa et al., 2020). As for language-spoken and visualisation, the primary outcome for teaching-learning with video is that learning with a blend of pictures and texts is more potent than learning with simple texts (Costa et al., 2020). The scholars add that an image with spoken texts is superior to just a picture. Likewise, printed and spoken texts are definitive to just pictures and texts (Costa et al., 2020). So for the creation of instructive video recordings, as supported by the scholars, pictures blend with the language spoken without excessive texts ought to be utilised.

As for simple videos, one ought to keep the video as basic as expected and avoid interruptions (Brame, 2016; Costa et al., 2020). It is essential to take out the material that does not add to the learning objectives, for instance, background noise, music and additional highlights that can distract attention (Costa et al., 2020). In light of valuable encounters, in an instructive video-recording, the presenter welcomes the learners first, furnishing them with a review of the impending theme and afterwards the presenter ought to vanish, and, before the conclusion of the video-recording the presenter shows up to thank the audience for watching and finishing on a farewell note (Costa et al., 2020). As for short videos, instructive video recording size is a significant variable to keep learners viewing until the end (Costa et al., 2020). The ideal duration for video recordings is six minutes at most (Costa et al., 2020).

The highest engaging video recordings were found with three-minute length, which agrees with scholars who found two to five minutes of video lengths favoured (Costa et al., 2020). Structuring a mixed media presentation into more modest parts has more impact than a no sectioned presentation (Costa et al., 2020). It is significant that the learners have command over the segments and press forward on the off chance that they are prepared and fully understand (Costa et al., 2020; Stohlmann & Acquah, 2019).

To encourage the learners, the presenter should sustain enthusiasm, talk more clearly, and loudly (Brame, 2016; Costa et al., 2020). Quick, innovative turn of events, just as lower editing, video-recording, and production costs, permit educators or learners to make their designs, utilise them in schoolroom settings, and improve teaching-learning (Costa et al., 2020). The scholars reiterate that learners are requested to examine the

topic and, from this, to set up a video recording. This way, the minimal cost of video recording is created by the learners and not by the educators (Costa et al., 2020). Giving the learners the responsibility of making their video recordings, the educators promote their engagement in the teaching-learning process, forcing the learners to learn by instructing (Costa et al., 2020). The educators are additionally expanding the learners' inspiration for learning Mathematics, making schoolrooms more active and collaborative (Costa et al., 2020, Olanrewaju, 2019). As pointed out by the scholars, the collaboration with the educator is enhanced, and their work is quick.

Technology can empower learners to embark on high demand tasks. Stohlmann and Acquah (2019) conducted an investigation from 2010 to 2019 to find the influence of technology in teaching Mathematics. They found that technology developments can change how Mathematics is imparted by improving effective teaching-learning practice. Technological innovation can consider new undertakings or improved tasks that assist learners make relations among illustration and safeguard in problem-solving, just as it empowers educators to inspire and utilise proof of learner-thinking in different ways (Stohlmann & Acquah, 2019). Thus, modern technology can enable learners to embark on high demand tasks (Stohlmann & Acquah, 2019). These undertakings utilise different illustrations and attention to Mathematics relationships, processes or concepts (Stohlmann & Acquah, 2019).

Technological innovation can help learners choose to make relations between illustrations (Stohlmann & Acquah, 2019). The learners could make the relations by analysing real-life video recordings and photographs, just as through powerful

Mathematical productions (Stohlmann & Acquah, 2019). Thus, learners can rapidly investigate various thoughts and get input on the outcome of their activities (Stohlmann & Acquah, 2019). Scaffolding can likewise be fused through significant inquiries that centre learners' reasoning and through the fuse of making other learners' sense noticeable to all learners (Stohlmann & Acquah, 2019). The scaffolding permits educators and learners to bring about and utilise proof of learner reasoning (Stohlmann & Acquah, 2019). When learners can undoubtedly see others' thoughts, it can prompt more extravagant conversation and comprehension (Stohlmann & Acquah, 2019). Learners do not see mathematics concept as exclusively dwelling in the educator yet as a typical collective concept building (Stohlmann & Acquah, 2019).

Technological innovation incorporation can include successful instruction practices that can assist learners with creating Mathematics comprehension. Stohlmann and Acquah (2019) enlist effective teaching practices and how technological innovation enhance the practice: Implementing tasks that advance thinking and problem-solving; Introducing game-based learning with more elevated level requests of reasoning; Utilise and associate Mathematics illustrations; Exploring relations between Mathematics illustrations through different cases with slides, active Mathematics constructions, and analyses of real-life photographs and video-recordings; Providing quick assignment and prepare feedback to learners including the comment for learners' activities with manipulative; Produce and utilise proof of learner reasoning; Supporting collaboration of the building of knowledge; Assisting with an acceleration of learners' thoughts; Enabling simple stockpiling of learners' views for future teaching and learning of Mathematics.

Technological innovation incorporation can include successful instruction practices that can assist learners with creating Mathematics comprehension (Stohlmann & Acquah, 2019). The most current principles and proposals for Mathematics educators suggest integrating technological innovation at all Grade-12 schoolrooms (Costa et al., 2020; Gain & Ancho, 2019; Stohlmann & Acquah, 2019). With the end goal for learners to be set up to be effective in their future professions, they need to have the correct encounters with utilising technological innovation (Stohlmann & Acquah, 2019). Technological innovation incorporation in Grade-12 Mathematics has gained more extensive consideration in the most recent decade as new advancements have been created and executed regularly (Stohlmann & Acquah, 2019).

School-related factors in four areas, such as school type, climate, resources, and learner enrolment, affect academic performance. Zilanawala**,** Martin, Noguera and Mincy (2018) **a**nalysed the variety in Mathematical performance trends of Black male learners to comprehend the various ways these learners effectively or ineffectively explore schools and the school qualities that are related to their trends. They found that school-related factors in four areas, such as school type, school climate, school resources, and learner enrolment, affect academic performance, which is frequently not easy to measure. However, a few investigations suggest that schools' instructive and social-related resources emphatically affect learners' academic results (Zilanawala et al., 2018). Then again, school-related resources, such as technology specialists, social employees, and counsellors, positively affect learner performance (Zilanawala et al., 2018).

There are significant factors that are non-mathematical that are identified with performance in Mathematics (Prado et al., 2020). These incorporate communication abilities, gender, vocabulary, educator factor, involvement of parents, financial status, language, and intelligence (Prado et al., 2020). Therefore, educators must utilise methodologies that enhance learning in complementing their pedagogical administration (Prado et al., 2020). The prevalence of extra after school lessons for East Asian learners as a significant contributor to their excellent performance cannot be denied (O'Dwyer et al., 2015). Global comparative research should gauge the impacts of after school lessons on learners' achievement and separate those impacts from the effects of formal educational structures of countries (O'Dwyer et al., 2015). Next is a discussion of a secondary school, an international school, and a state school.

Secondary School

The Global Competitiveness Index Report 2017 – 2018 states that South Africa was positioned 114th out of 124 countries in a study that placed 124 countries' education systems (Vermooten et al., 2020). As the scholars emphasise, the placement aligns with results from other international tests between 2002 and 2016. For example, the Trends in International Mathematics and Science Study, and Progress in International Reading Literacy Study, have reliably announced comparative degrees of educational accomplishment in South Africa (Vermooten et al., 2020). Deficient circumstances concerning time, yet an absence of similarity with the curriculum, have pertinent deterrents regarding the execution of ICT at school as observed by educators in secondary schools (Drossel et al., 2017). Secondary school learners' social and

academic requirements demand a more prominent number of functions and know-how that make tablet gadgets unattractive for a few (Varier et al., 2017). For instance, secondary school learners revealed that they utilised the tablets at home to finish assigned work and utilise their individual laptops or home PC for research-work or personal utilisation, such as playing games and utilising social-media (Varier et al., 2017).

The flexibility to finish assignments during spare time at school, type instead of writing, and submitting tasks online expands learner efficiency and reflects a more substantial commitment and engagement degree (Varier et al., 2017). Varier and Colleagues (2017) say that secondary school learners articulated that in the event that they had leisure time, they could pull their digital devices up and do homework rather than merely staying there doing nothing, and that made them more efficient. According to Halpern, Pina and Ortega-Gunckel (2020), past investigations have demonstrated that utilising digital resources for learning purposes can influence academic achievement in two ways (Halpern et al., 2020). First, access to numerous technology resources can encourage and promote the retention of more mind-boggling measures and advance active learning (Halpern et al., 2020). Likewise, it has been seen that utilising digital resources for understanding expands learners' interest and their development and involvement of cross-over skills (Claro et al., 2015; Halpern et al., 2020; Wang et al., 2018; Zhang, 2015). For example, coordinated effort and self-directed self-sufficient learning are positively identified with academic achievement (Claro et al., 2015; Halpern et al., 2020; Wang et al., 2018; Zhang, 2015).

Accessibility to an effective educator is the most significant school-related element for better learning (Superville, 2017). The educator quality is the main school-related element and can be more remarkable than numerous out-of-school elements (Superville, 2017). Educators are the main school-based elements for learner achievement (Superville, 2017). Learners are well competent to detect whether their educators are effective or not. The learners know when the educator cares, prepares for the lesson, and teaches well (Superville, 2017). When learners are given a whiling-away time work, they perceive that their time is misused and can lose learning interest (Superville, 2017). Therefore, as Superville (2017) puts it, numerous learners in Tobago and Trinidad are enrolled in out of school classes. That private-lesson culture, an expensive endeavour for guardians and parents, has become common in Tobago and Trinidad education systems (Superville, 2017).

Predictors of secondary school achievement or graduation are community context, friends, school, family, and individual (Zaff et al., 2017). By and large, learners' characteristics and background of their families have a much stronger influence over accomplishment or achievement than school factors (Agasisti & Longobardi, 2017). For good achievement in Mathematics to be realised, the integration of digital resources or ICT in the teaching-learning of Mathematics in Singapore, Norway, Netherlands, Germany, and Australia is a priority (Agasisti & Longobardi, 2017; Costa et al., 2020; Gain & Ancho, 2019; Stohlmann & Acquah, 2019). In several countries, the IT material of schools has observably improved (Eickelmann et al., 2017; Fraillon et al., 2014). Be that as it may, significant contrasts exist concerning the accessibility of PC based resources

(Eickelmann et al., 2017; Fraillon et al., 2014). On average, Eickelmann et al. (2017) discovered that five learners share one PC in the EU. A global contrast shows that two-thirds of learners in secondary schools are not or barely influenced by a need or deficiency of PCs utilised for teaching-learning purposes (Eickelmann et al., 2017). They are also not affected by a lack or poor quality of Internet availability (Eickelmann et al., 2017).

Results from the IEA investigation of TIMSS 2003 indicated that performance in Mathematics in all participating countries was positively related to the utilisation of PCs both at home and at school by learners (Eickelmann et al., 2017). However, learners' performance utilising PCs at home is not higher in each nation (Eickelmann et al., 2017). Some countries had no significant difference, while others had a significant difference when the learners' families' financial status is controlled (Eickelmann et al., 2017). A more continuous and frequent ICT utilisation at school correlates with lower performance (Eickelmann et al., 2017). Schools utilise ICT tools to help low-performing Mathematics learners (Eickelmann et al., 2017).

Based on PISA and TIMSS enormous scope assessment data, past research uncovered that a small number of school-level factors appeared to be related to learner achievement (Laukaityte & Rolfsman, 2020). No school-level factors in Sweden were significantly found to effectively correspond to achievement in Mathematics in TIMSS (Laukaityte & Rolfsman, 2020). They discovered that household-related background factors have various effects on learner's future performance in Mathematics across Finland (Harju-Luukkainen et al., 2020). All learners going to non-public schools in Caygill, Lang, and Cowles' (2010) study had administrators who detailed that resource

deficiencies had a negligible effect on Mathematics teaching and learning. However, the current research is not comparatively investigating school-related resources as determinants of Mathematics achievement among secondary school learners. The study comparatively investigates school-related resources as determinants of Mathematics achievement among IBDP learners doing Mathematics AA courses in South Africa and Singapore.

International School

Any school which offers international education is an international school. Hill (2016) explored some issues in characterizing an international school. First, the motivation behind a school could be viewed as a significant marker of whether it is more public or international (Hill, 2016). On the off chance that the chief object is to teach learners staying outside their country of origin (whether or not the curriculum is international or national) (Hill, 2016). If that design is met and not one of the abroad institutions administered and funded by a country state, the school will fit the international name school (Hill, 2016). Any school that offers international education is international (Hill, 2016). Third, an international school is an institution that offers its learners an education that is international with the help of its educational programme or curriculum (Hill, 2016). The global educational programme is the string that interfaces various sorts of international schools. Whether the school is officially connected with the United Nations private or state-supported or benefit or not-for-benefit or multinational regarding staff and learners or situated in the southern or northern side of the equator or housed in an ancient chateau or on a solid and fortified glass grounds (Hill, 2016).

Not all international schools offer worldwide or international education, yet many do. Both public and non-public schools can provide education that is international, and they are doing as such in growing numbers (Hill, 2016). Since not all international schools offer international education, there is a distinction between global and international education (Hill, 2016). That makes one isolate the nature of the school itself from the educational curriculum offered, its learners and administering bodies, whether the school is a profit or non-profit making school (Hill, 2016). According to Hill (2016, pp. 11–12), a pure national-independent (tuition-based) school: Be ultimately perceived/affirmed by the education administrators of the state; Be subsidized basically from learner expenses and may get a slight government appropriation; Be answerable to an overseeing body free of the state-run administration; Have socially and traditionally identical learners and staff from within the nation; Chooses its admission measures as long as they are as per the laws of the government; Offer a curriculum endorsed by the country state; Is set up for the children of guardians who wish to have an option in contrast to the national education system; And may work as a not-for-benefit or for-benefit lawful unit.

In modern times, a growing number of public schools likewise teach an international curriculum, and others look to bring a perspective that is international into national curricula (Hill, 2016). According to Hill (2016, pp. 12–13), a pure-international school will: Have a traditionally different learner-body without any advantages to any religious or specific ethnic group; Sets its admission measures that are generally very inclusive of learners with bodily and intellectual incapacities; Offer a suitable curriculum of education that is international; Have been set up chiefly for the children of worldwide

travelling guardians or to advance worldwide mindedness by wilfully bringing learners from numerous nations collectively in one spot.

A growing number of public and state independent schools are offering, for instance, an IB programme concurrently with a national curriculum as a rule (Hill, 2016). Lee, Walker and Bryant (2018) Investigated practices in leadership related to International Baccalaureate (IB) learner-achievement. Lately, research studies have zeroed in on the difficulties experienced by leaders in IB schools in light of the fact that IB schools have been the quickest developing subset of worldwide education. However, the current study is not comparatively investigating school-related resources as determinants of Mathematics achievement among learners in international schools. Instead, the study comparatively investigates school-related resources as determinants of Mathematics achievement among IBDP learners doing Mathematics AA courses in South Africa and Singapore. Next, the researcher discusses a state school.

State School

Most learners in a public school are initially from within the country and are taught the country-state curriculum. According to Hill (2016, pp. 11–12), a pure-national state institution: Is inclusively in accordance with its commitments; Its available to all learners living within the country paying little heed to financial class, academic abilities, beliefs, tradition, handicap, and so forth; Offers an educational curriculum endorsed by the country state; Be entirely financed by the country state; Be answerable to the Ministry of Education; Have traditionally homogeneous staff and learners from within the country;

And hire educators as public-servants. Thus, most learners in a public school are initially from within the country and are taught the country state curriculum (Hill, 2016).

A growing number of public and state independent schools are offering, for instance, an IB programme concurrently with a national curriculum as a rule (Hill, 2016). The IBO presently offers four IB programmes and has moved considerably over ongoing years into state-financed schools, particularly in Ecuador and the United States (Bunnell, 2016). However, the current study is not comparatively investigating school-related resources as determinants of Mathematics achievement among learners in state schools. Instead, the study comparatively investigates school-related resources as determinants of Mathematics achievement among IBDP learners doing Mathematics AA courses in South Africa and Singapore. Next, the researcher discusses education in the Asia-Pacific region.

Education in Asia-Pacific

Countries over the Asia-Pacific locale have exhibited rehashed achievement in global academic tests. Most significantly, the 2012 Program for International Student Assessment (PISA) outcomes uncovered that the best seven achievers for 15-year-olds as to mean scores for Mathematics were entirely sited in East Asia, a sign of outstanding achievement for the Asia-Pacific countries (Wright et al., 2016). However, the current study is not comparatively investigating school-related resources as determinants of Mathematics achievement among Asia-Pacific learners. Instead, the study comparatively investigates school-related resources as determinants of Mathematics achievement among IBDP learners doing Mathematics AA courses in South Africa and Singapore.

Education in Africa

The way PCs are utilised essential to see how they can affect achievement. Smith and Hardman (2014) conducted a study on the effects of PCs on the achievement of learners in final Senior Certificate Mathematics in South Africa. The results demonstrated that: There were no significant changes in Higher Level Mathematics selection; There were no substantial changes in the number of learners that passed Senior Certificate Mathematics; There were no essential changes in the outcomes after the Khanya PC laboratories were introduced; There was no significant distinction between the final Senior Certificate Mathematics grades of schools with PCs and those which do not have PCs (p. 35). No significant changes were found in Matric Mathematics grades, both after and before the Khanya PC mediation (Smith & Hardman, 2014). Smith and Hardman's (2014) exploration indicated that unaided PCs could not affect Mathematics achievement.

South Africa is positioned second from the bottom internationally in Mathematics capability (Smith & Hardman, 2014). Hence the introduction of the Khanya project that integrates computers into schools to alleviate the problem and to construct a technological ability in the whole nation, particularly in impeded schools (Costa et al., 2020; Gain & Ancho, 2019; Smith & Hardman, 2014; Stohlmann & Acquah, 2019). In the same way as other nations, South Africa requires a consistent and expanding stream of human resources that is innovatively advanced to satisfy the technological and scientific requirements (Letsoalo et al., 2019). Simply put, the globe demands human resources that are innovatively proficient and compliant (Letsoalo et al., 2019). The Mathematics

crew is seriously worried about the lack of Mathematics related abilities in the labour force, particularly the deficiency of Mathematics instructors (Letsoalo et al., 2019).

South African specialists have continuously decried about the low attainment of learners in South Africa on a standardised Mathematics test compared with learners from different countries (Letsoalo et al., 2019). Specifically, it involves worry that the Trends in International Mathematics and Science Study (TIMSS) discovered that South African learners' Mathematics achievement in the ninth grade in TIMSS 2025 was far lower than the global-point benchmark of 500 (Letsoalo et al., 2019). Out of 63 countries that participated in TIMSS 2015, South Africa was positioned in the last 6 in Mathematics achievement (Letsoalo et al., 2019). A few investigations have indicated that school resources are connected with learners' enhanced scholarly attainment (Letsoalo et al., 2019). Learners in South Africa who come from low-income families, whenever allowed a chance to go to well-resourced schools, are frequently ready to fundamentally improve their Mathematics abilities (Letsoalo et al., 2019). However, the current study is not comparatively investigating school-related resources as determinants of Mathematics achievement among African learners. Instead, the study comparatively investigates school-related resources as determinants of Mathematics achievement among IBDP learners doing Mathematics AA courses in South Africa and Singapore. Next, the researcher discusses Singaporean education.

Education in Singapore

Singapore has been top-rated, positioned as having the most noteworthy performing schools (Arifeen, 2017). It has produced the top performing learners in

Mathematics in global ranks in the Program for International Student Assessment (PISA) test conducted by the Organization for Economic Cooperation and Development (OECD) in 2015 (Arifeen, 2017). Singapore was top in all PISA rankings in educational systems across North America, South America, Australasia, Europe, and Asia (Arifeen, 2017). Singapore takes the lead as Asian countries (South Korea, China, Japan, Taiwan, Macao, and Hong Kong) dominate Mathematics performance (Arifeen, 2017). Singapore and the other Asian nations perform best without stark contrasts between learners from affluent and distraught families (Arifeen, 2017). Although with a minimum gap between poor and affluent families, Singapore produces top Mathematics results (Arifeen, 2017). It is worth noting that Mathematics teaching would never surpass the quality of its educators (Arifeen, 2017).

Recruiting top alumni into the education profession in Singapore is a topmost priority (Arifeen, 2017). For the most part, Singapore is dedicated to schooling to build up its economy and escalating life standards (Arifeen, 2017). As one of the emerging countries, with a blend of nationalities, religions and dialects, Singapore has outperformed the wealthiest nations in Asia, North America, and Europe to become a top country in educational achievement (Arifeen, 2017). Intending to raise the status and prestige of the education profession and attract the best alumni, Singapore made a heavy investment in quality educators (Arifeen, 2017). As a result, Singapore tops the world best ten performing nations in Mathematics (Italy, the United States of America, the United Kingdom, Australia, Finland, Taiwan, Japan, South Korea, and Hong Kong) (Arifeen, 2017). Hong Kong is second after Singapore, and Italy is the least performing among the

ten countries (Arifeen, 2017). Greater learner engagement in Singapore is perceived as a requirement in the schoolroom to improve the implementation of 21st-century skills (Peacock et al., n.d.).

Singaporean schools are changing from the traditional teaching-learning approach, drill-and-practice, to learner engaging approaches (Peacock et al., n.d.). A 21st century engaged learner is self-focused and ready to outline and explain his learning objectives and performance (Peacock et al., n.d.). Singapore is a 4 million people island without natural resources and covers a square-kilometre area of 640 (Peacock et al., n.d.). Therefore, the Singaporean government invests education in its people as its solitary resource (Peacock et al., n.d.). To increase school performance for every learner, the Singaporean government offers opportunities through its meritocratic educational structure (Peacock et al., n.d.). A Singaporean learner starts elementary education at six years old in a system that takes six years (P1 to P6), starting from P1 (Peacock et al., n.d.). Elementary school education culminates with an external examination known as Primary School Leaving Examination (PSLE), which is used to determine secondary school opportunities accessible for the learners (Peacock et al., n.d.).

The University of Cambridge International Examinations and the Singaporean Ministry of Education jointly offer the 4-year General Certificate of Education (GCE) Ordinary Level (O-level) for learners who passed the Primary School Leaving Examination (PSLE) (Peacock et al., n.d.). Learners with more poor PSLE grades enrol on a five or 4-year parallel course at the secondary school level (Peacock et al., n.d.). These learners have the chance to graduate with a 4-year Singaporean-Cambridge

General Certificate of Education (GCE), Normal Academic (N(A)) or a 5-year Singaporean-Cambridge General Certificate of Education (GCE) Ordinary Level (O-level) (Peacock et al., n.d.). A third alternative offer at secondary school is the Singaporean-Cambridge General Certificate of Education (GCE) Normal Technical (N(T)) level, a little more coursework oriented course (Peacock et al., n.d.).

As of late, Singapore has performed well in worldwide tests like Program for International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS) showing top country strength in Mathematics (Peacock et al., n.d.). However, educators encountered that learners who battle Mathematics frequently have negative self-concept and nervousness in Mathematics, hindering learning advancement (Yi & Lee, 2017). Consequently, persuading learners and encouraging positive self-concept and efficacy in Mathematics is just about as significant as enhancing the Mathematics achievement of learners (Yi & Lee, 2017). In such a manner, urging educators to utilise more alluring teaching approaches is pivotal for success in education (Yi & Lee, 2017). Thus, learner-centred instruction undesirably affected interest in Mathematics just as Mathematics achievement in Korea, yet positively affected interest in Mathematics in Singapore (Yi & Lee, 2017).

It was noticed that support for educators' learning for Korea and Singapore was a positive indicator of interest in Mathematics and Mathematics achievement (Yi & Lee, 2017). The scholars report that educators who establish a learning climate where all learners can feel prosperous and progress underscore challenges, improvement, and exertion. These fundamental components of supportive learning may prompt effective

learning (Yi & Lee, 2017). In addition, high-achieving learners positively endorse learning support and schoolroom management (Yi & Lee, 2017). The high-achieving learners' perception might be because of the propensity that low-achieving learners need more individualised and non-rushed schoolroom instructions reasonable for their condition of learning (Yi & Lee, 2017). In addition, small group activities might benefit more from producing answers by a joint effort to cultivate their motivation (Yi & Lee, 2017).

Learner-centred instruction may not be successful if it neglects to engage learners in the teaching-learning process, making them work on mathematics-related problems (Yi & Lee, 2017). Accordingly, educators must invest more energy to support low-achieving learners in intellectually challenging undertakings (Yi & Lee, 2017). Throughout the previous three decades, the structure for the Singaporean school Mathematics educational plan has set accentuation on attitudes, metacognition, processes, skills, and concepts that contribute to the essential objective of Mathematics teaching of problem-solving (Kaur et al., 2018). However, the current study is not comparatively investigating school-related resources as determinants of Mathematics achievement among Singaporean learners. Instead, the study comparatively investigates school-related resources as determinants of Mathematics achievement among IBDP learners doing Mathematics AA courses in South Africa and Singapore. Next, the researcher discusses South African education.

Education in South Africa

Teaching-learning of school Mathematics in South Africa has been articulated to be amongst the most noticeably poorest worldwide (Jojo, 2020). Unrecognized poor

Mathematics teaching in a more significant part of state-funded schools denies numerous learners admittance to advanced education and current, escalated-knowledge job abilities (Jojo, 2019; Jojo, 2020; Soudien & Chisholm, 2021). The curriculum of Mathematics in South Africa has been significantly reformed with the end goal that the research community in Mathematics education has additionally developed notably (Jojo, 2020; Soudien & Chisholm, 2021). Numerous progressions, noted Jojo (2020), occurred following the South African democratic elections of 1994, and the most remarkable change has been in the space of schooling. At first, The Department of Basic Education (DBE) revealed the Outcomes-Based Education (OBE) driven educational programme known as curriculum 2005 (Jojo, 2020; Khuzwayo & Mncube, 2017; Musitha & Mafukata, 2018). However, it was predominantly described by collaborative group teaching, making it hard for educators to notice learners needing help in Mathematics (Jojo, 2020; Musitha & Mafukata, 2018).

After its introduction in 1997 to eliminate past curricular divisions as a result of apartheid, the outcomes-based education (OBE) was revised in 2000 after yielding unpleasant outcomes from the experience of its execution by partners (Jojo, 2020; Khuzwayo & Mncube, 2017; Musitha & Mafukata, 2018). In 2002, the National Curriculum Statement for grade 10 to grade 12 was introduced after revising the National Curriculum Statement (RCNS) of grade R to grade 9 (Jojo, 2020; Maharajh, Nkosi, Mkhize, 2016). Unfortunately, the Revised Curriculum National Statement (RCNS) framework fizzled because the educators could not comprehend it and frequently could not see the distinction between curriculum 2005 and the revised curriculum national statement

(RCNS) (Jojo, 2020; Maharajh, Nkosi, Mkhize, 2016). The outcome was that the execution difficulties of RCNS were equivalent to those of curriculum 2005 (Björklund, 2015; Jojo, 2020; Khuzwayo & Mncube, 2017; Maharajh, Nkosi, Mkhize, 2016).

Additionally, it unfolded that RCNS was profoundly stacked and missed the mark concerning its assumptions, utilised dubious complex wording and insufficient training of educators and regional authorities (Jojo, 2020; Maharajh, Nkosi, Mkhize, 2016). The RCNS was reviewed, and Curriculum and Assessment Policy Statement (CAPS) was introduced in 2012 and carried out in all school levels of South Africa (Jojo, 2020; Maharajh, Nkosi, Mkhize, 2016). The OBE is the fundamental philosophical support of CAPS (Carnoy, Chisholm, Chilisa, 2012; Jojo, 2020). Currently, CAPS is a South African educational plan practised as an action that changes the disparities and lopsided characteristics of the past (Jojo, 2019; Jojo, 2020). In 2012 January, a solitary extensive Curriculum and Assessment Policy Statement was produced for all subjects to Subject Assessment Guidelines, supplant Learning Program Guidelines, and Subject Statements in grade-R to grade-12 (Jojo, 2019; Jojo, 2020).

The phases of school Mathematics in South Africa are further education and training (FET) (grade 12-10), senior phase (9-7), intermediate phase (6-4), and foundation phase (3-R) (Jojo, 2019; Jojo, 2020). CAPS is non-flexible and stresses consistent execution (Jojo, 2019; Jojo, 2020; Shalem, De Clercq, Steinberg, Koornhof, 2018). The non-flexibility was imposed because the autonomy with the execution of changes in the curriculum was counter-useful. After all, Mathematics achievement remained poor (Jojo, 2020; Shalem et al., 2018; Soudien & Chisholm, 2021). The non-improvement in

Mathematics was observed from the Southern and Eastern Africa Consortium for checking Educational Quality (SACMEQ), Trends in Mathematics and Science Study (TIMSS), and public school assessment tests (Jojo, 2019; Jojo, 2020; Soudien & Chisholm, 2021).

From 2016, in all technical schools, Technical Mathematics was introduced, evidently indicating that the changes in the South African curriculum are still in progress (Jojo, 2019; Jojo, 2020). Mathematical Literacy was introduced with the curriculum adjustments as a choice to be taught to learners who could not do Mathematics in the further education and training (FET) phase (Jojo, 2019; Jojo, 2020). By the time they graduate, all learners are guaranteed to have been taught a specific type of Mathematics (Jojo, 2019; Jojo, 2020). South Africa's poor achievement in matric examinations, the high-stake public yearly grade 12 examinations, and the continued positioning at the lower part of TIMMS achievement tests follow an interminable theory about the causes and reasons for the poor Mathematics achievement (Jojo, 2019; Jojo, 2020).

The South African Minister of Education observed that South Africa is failing to meet expectations in the teaching-learning of Mathematics (Jojo, 2020; Motshekga, 2013). Mathematics schoolroom instruction is frequently of low quality, with educators unable to answer question items of the subject they teach (Jojo, 2020; Molapo & Pillay, 2018; Motshekga, 2013). The overabundance supply of unskilled labour and salary imbalance aggravates South African Mathematics achievement (Jojo, 2019; Jojo, 2020; Molapo & Pillay, 2018). From the apartheid, the Mathematics education system of South Africa inherited educators with certificates and diplomas instead of degrees, who were

undertrained in taking care of the substance of the new educational plan (Jojo, 2020; Khuzwayo & Mncube, 2017; Molapo & Pillay, 2018). Roughly 20 per cent of grades 10-12 Mathematics educators are competently unfit, and 21 per cent of the skilled educators have university qualifications (Jojo, 2020; Molapo & Pillay, 2018).

A portion of the certified Mathematics educators either work in school administration positions making the human resource that can help with Mathematics instruction scarce (Jojo, 2019; Jojo, 2020; Molapo & Pillay, 2018). This situation has worsened, observed the scholars, to a level wherein the Minister of Education lowered the passing mark for Mathematics at grade-12 national examination to 20 per cent nationwide (Jojo, 2019; Jojo, 2020; Molapo & Pillay, 2018). This politically motivated choice impacts South Africa's economy as matric graduates cannot select rare-skilled courses at college/university even though they have passed. The B.Ed. (Bachelor of Education) South Africa is a 4-year programme (Jojo, 2019; Jojo, 2020; Molapo & Pillay, 2018). Pre-service educators preparing to be Mathematics instructors, add the scholars, will do Mathematics up to second-year courses. The scholars conclude that other candidates would select for a low-ranking B.Sc. degree and then do a PGCE (postgraduate certificate) for one year in Mathematics didactics. However, the current study is not comparatively investigating school-related resources as determinants of Mathematics achievement among South African learners. The study comparatively investigates school-related resources as determinants of Mathematics achievement among IBDP learners doing Mathematics AA courses in South Africa and Singapore.

International Baccalaureate (IB) Schools

The IBDP has increased in countries that speak English to become Anglo-driven indeed. Australia, England, Canada, and the United States of America combined had 61 per cent overall of all IB world schools in existence internationally as of July 2009 (Donovan & Lakes, 2017).

International Baccalaureate Centre

The International Schools Examination Syndicate (ISES) began in 1964, a body that was extensively involved to an extent in advertising activities and which in 1968 formally turned into the Geneva-based International Baccalaureate Organisation (IBO) office (Bunnell, 2016). The International Baccalaureate (IB) is a worldwide educational organisation that provides global assessment, curricula and programmes to schools around the planet (Sanders & Ishikura, 2018). The International Baccalaureate (IB) is a more than a 52-year-old non-profit driven organisation with the goal of making a superior, more serene world through excellent, global schooling (International Baccalaureate Organisation, 2021d; Jamal, 2016). As of February 2021, the IB works in more than 158 countries and involves more than 5,400 schools and 1.4 million 3-19-year-old learners (International Baccalaureate Organisation, 2021d). IB programmes are available in schools with different contextual situations around the world, namely religious-based and secular, single-sex and co-educational, private and public, national and international (Kidson, Odhiambo & Wilson, 2019). The IB organisation offers four programmes, all of which advance the educational development of the entire individual, emphasising social

and physical development, emotional, intellectual, including the customs of learning in arts, Mathematics, Sciences, Humanities, and Languages (Jamal, 2016).

The four IB programmes are not pre-requisite, and IB-world schools are free to offer at least one of the four IB programmes (Jamal, 2016). The IB Programmes offered are International Baccalaureate Diploma Programme (IBDP), launched in 1968 for 16-19-year-old learners, International Baccalaureate Career-related Programme (IBCP) launched in 2012 for 16-19-year-old learners, International Baccalaureate Middle Years Programme (IBMYP) launched in 1994 for 11-16-year-old learners, and International Baccalaureate Primary Years Programme (IBPYP) launched in 1997 for 3-12-year-old learners (Dickson, Perry & Ledger, 2018; International Baccalaureate Organisation, 2021c; Jamal, 2016; Kidson et al., 2019; Sanders & Ishikura, 2018; Storz & Hoffman, 2018a). Before introducing the offices regionally, IB-world schools from around the globe were authorised by the IB organisation head offices in Switzerland, Geneva, the primary area for the IB organisation since the mid-1960s (Hill, 2018). Next, the researcher discusses the International Baccalaureate Primary Years Programme (IBPYP) schools.

International Baccalaureate Primary Years Programme (IBPYP) Schools

The International Baccalaureate Primary Years Programme (IBPYP), an educational plan structure for learners ages 3-12. Gough Sharpley, Pal and Griffiths (2014) explored the effect of IBPYP execution on learner results, academic practice and school tradition in schools approved to offer the IBPYP. The International Baccalaureate Primary Years Programme (IBPYP), an educational plan structure for learners ages 3-12, emphasises developing the learner entirely as an inquirer, both in the schoolroom and

earth wide (Dever & Raven, 2017; Dickson, Perry & Ledger, 2017; Gough et al., 2014; Holman, Pascal, Bostan, Hojbotă & Constantin, 2015; International Baccalaureate Organization, 2021c; Jamal, 2016). The IBPYP has developed considerably since its dispatch in 1997 and presently has more than 1300 approved schools in more than 100 nations (Dever & Raven, 2017; Dickson et al., 2017; Jamal, 2016; Kidson, Odhiambo & Wilson, 2019; Storz & Hoffman, 2018b).

The IBPYP is an educational programme structure, with subject-specific desires presented in group and scope reports (Jamal, 2016). Schools may receive these scopes and grouping material or incorporate the IBPYP system with other public or district educational programmes (Jamal, 2016). The flexibility of the IBPYP gives the schools the adaptability to build up their own interesting coordinated educational programme (Jamal, 2016). Over fifty per cent of all IB schools are state-financed, ascribed to IB programmes' integration ability (Jamal, 2016). The IBPYP can uphold positive learner results in state schools and results for regular countrywide tests (Gough et al., 2014). The IBPYP educational programme substantially influences schools' choice to seek approval, as it was viewed as a good and tested worldwide educational programme that engages and challenges learners (Gough et al., 2014).

Issues and difficulties encountered by schools while executing the IBPYP include financial challenges, mainly in connection with IBPYP staff development costs, staffing the school with fitting staff and overseeing different teaching capacities (Gough et al., 2014). In addition, performance in IBPYP Mathematics in America depends on the school's state (Hemelt, 2015). Jamal (2016) studied inadequacies and holes in IBPYP

educational programme reports and recommended potential methods for upgrading the adequacy of the IBPYP and its educational programme records. The IBPYP consolidates trans-disciplinary, learner-centred and inquiry-based learning while at the same time zeroing in on the comprehensive improvement of learners (Dickson et al., 2017; Jamal, 2016).

The main focus of the IB is the obligation to worldwide mindedness, which advances intercultural instruction (Jamal, 2016). The outcomes from the state-sanctioned test examination utilised in this investigation demonstrated that performance in the PYP schools commonly surpassed performance among other high docile schools countrywide (Kushner et al., 2016). However, the current study is not comparatively investigating school-related resources as determinants of Mathematics achievement among IBPYP learners. Instead, the study comparatively investigates school-related resources as determinants of Mathematics achievement among IBDP learners doing Mathematics AA courses in South Africa and Singapore. Next, we discuss the International Baccalaureate Middle Years Programme (IBMYP) schools.

International Baccalaureate Middle Years Programme (IBMYP) Schools

The IBPYP was first introduced in 1997, and the International Baccalaureate Middle Years Programme (IBMYP) was first started in 1994 (Dever & Raven, 2017; International Baccalaureate Organisation, 2021c; Kidson et al., 2019; Storz & Hoffman, 2018a; Walker, Bryant & Lee, 2014). They both indicate significant development in the last decade, even though the International Baccalaureate Diploma Programme (IBDP) is still leading (Kidson et al., 2019). The International Baccalaureate (IB) has become a

ground-breaking instructive brand by building upstanding for consolidating reformist methodologies with scholastic thoroughness (Wright et al., 2016). The prominancy of the IBDP can be recognised by the increasing number of schools embracing IB programmes worldwide, particularly in the IB Asia-Pacific (Wright et al., 2016). As a component of this pattern, the IB Middle Years Program (IBMYP), focused on learners somewhere in the range of 11 to 16 years old, has increased altogether as of late (Dever & Raven, 2017; International Baccalaureate Organisation, 2021c; Storz & Hoffman, 2018a; Wright et al., 2016). Notwithstanding, the IBMYP stays less well known in Asia-Pacific than the IBPYP and pre-college Diploma Programme, the International Baccalaureate Diploma Programme (IBDP) (Wright et al., 2016).

Holistically learning and inter-disciplinary instruction are the primary standards of all programmes in IB (Dickson et al., 2018). Holistically learning is the thought that all information is interconnected in an educational programme that builds up the individual entirely, and inter-disciplinary instruction is the cycle by which the learner comes to comprehend groups of information from at least two subjects and integrates them to make fresh comprehension (Dickson et al., 2018). IB programmes depend on thinking (philosophy), where the learning process is concept-driven, learner-centred and inquiry-based (Dickson et al., 2018). Learners are viewed as knowledge-constructors, and the function of educators is to encourage learning instead of lecturing (Dickson et al., 2018). Therefore, educators are urged to utilise approaches that build up learners' researching aptitudes and critical reasoning abilities (Dickson et al., 2018; Lee et al., 2017).

Educators are urged to grasp the philosophy and change their educational programmes and teaching methods to align with the IB philosophy (Dickson et al., 2018). IB anticipates that its approved programmes should advance worldwide citizenship, global mindedness, and inter-cultural comprehension (Dickson et al., 2018). Clear objectives can be accomplished by discussing global problems and learning different cultures and languages (Dickson et al., 2018). The IBPYP and the IBMYP do not endorse a specific educational programme content, yet they specify how educators should instruct and evaluate concepts (Dickson et al., 2018). IBPYP learners complete an inside and out, a synergistic task called the IBPYP Exhibition, and IBMYP learners do a Personal Project (Dickson et al., 2018). Although in IBPYP, there is no set examination and grades are not moderated, starting from 2016, the IBMYP's Personal Project is moderated externally (Dickson et al., 2018). Likewise, schools can enlist a non-obligatory IBMYP e-Assessment to evaluate learners' work in different areas of the IBMYP (Dickson et al., 2018).

IBMYP learners benefit over learners who are in non-IB programmes (Dever & Raven, 2017). The scoring of IBMYP learners on the International Survey shows that IBMYP learners score higher than other learners, particularly in cultural pluralism, which is gratitude for various cultures and comprehending that they are all equivalent (Dever & Raven, 2017). The IBMYP learners often participate in a help and learning venture outside and inside their schools (Dever & Raven, 2017). IBMYP learners additionally report a more elevated level of by and sizeable psychological wellness when measuring one’s emotional state on various scales (Dever & Raven, 2017). The IBMYP, specifically, has battled to have an effect in the 11 to 16-year-old group (Haywood, 2018). However,

the current study is not comparatively investigating school-related resources as determinants of Mathematics achievement among IBMYP learners. Instead, the study comparatively investigates school-related resources as determinants of Mathematics achievement among IBDP learners doing Mathematics AA courses in South Africa and Singapore. Next, the researcher discusses the International Baccalaureate Diploma Programme (IBDP) schools.

International Baccalaureate Diploma Programme (IBDP) Schools

The International Baccalaureate (IB) Programme started in Geneva, Switzerland, in 1968 to help learners from families with international-related occupations (International Baccalaureate Organisation, 2021c; Kidson et al., 2019; Saira, 2017; Storz & Hoffman, 2018b). At first, IB offered its IB Diploma Programme (IBDP) to secondary-school-aged learners in a small bunch of tuition-based schools, zeroing in on advancing global comprehension (Storz & Hoffman, 2018a). As a result, IB acquired a standing as a tremendous instructive programme and was perceived by universities and colleges as giving solid scholastic preparation (“Key Findings from Research on the Impact of the Diploma Programme,” n.d.; Saavedra, 2014b; Sanders & Ishikura, 2018; Storz & Hoffman, 2018b). The IB is a four-programme education developed for primary and secondary learners (Dickson et al., 2018). The IB Diploma Programme (IBDP) was designed for learners with ages 16 to 19 years and was the initial programme to be offered in 1968 (Dickson et al., 2018; International Baccalaureate Organisation, 2021c; Kidson et al., 2019; Sanders & Ishikura, 2018; Storz & Hoffman, 2018a).

The IBDP was trailed by the IB Middle Years Programme (IBMYP) for 12 to 16-year-old learners and was first offered in 1994 (Dickson et al., 2018; International Baccalaureate Organisation, 2021c; Storz & Hoffman, 2018b). The IBMYP was followed by the IB Primary Years Program (IBPYP) for 3 to 12-year-old learners and was first offered in 1997 (Dickson et al., 2018; International Baccalaureate Organisation, 2021c; Storz & Hoffman, 2018a). Finally, the IB Career-related Programme (IBCP) for 16 to 19-year-old learners was introduced for learners in the final two years of their secondary education and was developed for learners who are involved in career-based education as an option in contrast to the IBDP (Dickson et al., 2018; International Baccalaureate Organisation, 2021c). As the most up to date offers, the IBCP is the least regularly offered IB programme (Dickson et al., 2018). The IBDP is the top mainstream of the four IB programmes in over 3,659 schools worldwide (Dickson et al., 2018). As of 2021, IB programmes are offered around the globe in more than 5,000 schools, of which over 60% of IB programmes are in the Americas, and 90% of IB programmes in the United States (USA) are in government-funded schools (International Baccalaureate Organisation, 2021c; Storz & Hoffman, 2018a).

IB can be followed back to 1962, when the IBDP was first proposed (Dever & Raven, 2017). After extended discussion, the International Schools Association perceived the requirement to add an extra programme that readied learners' IBDP (Dever & Raven, 2017). Thus, they made a Pre-IBDP programme, which was ultimately taken over by IBO in 1992 and gave it a new name as IBMYP (Dever & Raven, 2017). The IBDP was introduced as a remedy of the effects of the Second World War with the goal of advancing

understanding of intercultural and world peace (Jamal, 2016). This responsibility stays at the core of the IB statement of purpose and a philosophy shared to each of the four IB programmes (International Baccalaureate Organisation, 2021i, p. 1): The IB aims to develop caring, knowledgeable and inquiring learners who service to make a more peaceful and better world by means of respect and intercultural comprehension. Thus, the overall direction of the IBDP programme is essentially all-encompassing and humanistic, worries about learners' capability to develop in ways that are harmonious, and not zero in just on acquiring grades and converting learners into "exam-performers", which is an instructive worldview that is customarily advanced by traditional education systems (Holman et al., 2015).

The IB programmes advance positive personality ethics considered by experts as a bunch of ethically and innately esteemed (Holman et al., 2015). The endorsed guidelines of the IB programmes, abbreviated in the "IB-learner-profile", depict them as intending to cultivate a bunch of the following components of personalities in learners (International Baccalaureate Organisation, 2021h): a) "Balanced", alludes to the comprehension of the significance of adjusting various traits of life, such as emotional, physical, and intellectual; b) "Reflective", that is having a smart thought of the world and one's very own experiences and ideas; c) "Risk-takers", alludes to the way that learners would build up the ability of being resolved, ingenious and tough despite difficulties and change; d) "Caring", is demonstrating respect, compassion, empathy, and eagerness to influence a beneficial outcome in the lives of other persons; e) "Open-minded", meaning that learners ought to fundamentally value their way of life and individual histories, yet

additionally other persons' standards and customs; f) "Principled", meaning that learners ought to action with trustworthiness and integrity, in this way taking accountability regarding individual moves and their outcomes; g) "Communicators", alluding to the objective of assisting learners to communicate creatively and confidently, and to accept other persons' viewpoints; h) "Thinkers", meaning that the IB programme endeavours to energise the utilisation of innovative reasoning and critical abilities on multifaceted challenges; i) "Knowledgeable", alluding to the advancement of comprehending concepts, interdisciplinary approaches and engagement in challenges that have international and local importance; j) "Inquirers", meaning that the IB programmes try to sustain interest, cultivating abilities for research and inquiry (p. 1).

A successful school promotes a school-wide message that urges learners to see themselves as talented for performing at elevated levels. According to Barnett, Avila & Aklog (2017), a successful school works to establish a school climate that challenges learners but support and encourage them at the same time. As Barnett, Avila and Aklog (2017) point out, offering a diversity of choices for IBDP learners, from taking one class to doing the full IBDP. According to Barnett, Avila and Aklog (2017), a successful school provides help lessons for learners with special needs. According to Barnett, Avila & Aklog (2017), a successful school provides staff resources to learners (for example, clinicians, psychologists, social workers, and career-guidance specialists) to help learners tackle difficult subjects like that needed in the IBDP. According to Barnett, Avila and Aklog (2017), a successful school puts up help structures (a learning-support department) to give individual social-emotional counsel and academic help.

A successful school encourages learners, gives organized experiences, provides facilities, opens doors for learners to work in groups, and cultivates self-knowledge. According to Barnett, Avila and Aklog (2017), a successful school gives a bunch of organised experiences allowing learners to develop mentally, for instance, organising the extended-essay in IBDP to encourage learners to construct a conviction that they can handle a challenging, long-term exploration. In addition, according to Barnett, Avila and Aklog (2017), a successful school provides facilities to create supportive learner groups that can be continued over the long run—for instance, allocating learners to homerooms toward the start of their secondary school with a lead educator who remains with the learner-group until matriculation. The lead educator would then be able to monitor how each learner gets along academically and socially, with an option of intervening when things are not moving in the right direction.

A successful school encourages learners to participate in activities and clubs that strengthen their relationship with the school. According to Barnett, Avila and Aklog (2017), a successful school opens doors for learners to work in groups, encouraging connection and community. According to Barnett, Avila and Aklog (2017), a successful school encourages learners to follow their interests and promote learning more about themselves through service (CAS), activities, creativity, sports, and arts.

A successful school encourages learners to take on positions of authority in learner government, sports, clubs, or different undertakings, permitting them to build self-confidence in various roles and circumstances. According to Barnett, Avila and Aklog (2017), a successful school cultivates self-knowledge by offering open doors for learners

to reflect on areas of a strong point and embrace territories they might want to improve. According to Barnett, Avila and Aklog (2017), a successful school provides an opportunity for learners' autonomous choice-making through components of the IBDP, for example, CAS, the extended essay, and theory of knowledge. The IB gives high-quality education to all learners in the United States of America (USA) (Beckwitt et al., 2015). The IB promotes global-mindedness among educators, learners, and administrators (Beckwitt et al., 2015).

The IB gives a reliable programme structure; in the USA, it is aligned with USA schools' programmes (Beckwitt et al., 2015). The IBDP is significantly less accessible in countryside societies in the USA than in urban communities (Dickson et al., 2017). The IB prepares learners well for the meticulousness of college-level studies (Ateşkan, Sagun, Sands & Çorlu, 2015; Beckwitt et al., 2015; Saavedra, 2014b; Sanders & Ishikura, 2018). The IB offers opportunities and incredible programmes that go past school, such as the community service course (Beckwitt et al., 2015). The IB assists with cultivating study abilities and a hard-working attitude among learners (Beckwitt et al., 2015). The state-wide implementation of the IB programme draws learners from different regions or non-public schools (Beckwitt et al., 2015).

The IB alignment requirement with state norms and the IB and inadequate financing expense are two known difficulties related to IB implementation (Beckwitt et al., 2015). However, the current study is not comparatively investigating school-related resources as determinants of Mathematics achievement among IBDP learners. On the other hand, the study comparatively investigates school-related resources as

determinants of Mathematics achievement among IBDP learners doing Mathematics AA courses in South Africa and Singapore. Next, we discuss teaching-learning in IB.

Teaching-learning in IB.

The IB programme's mission was to give worldwide schooling that would empower learners to comprehend and deal with the complexities of our global reality more readily. Beckwitt, Van Camp and Carter (2015) explored IB introduction of the Diploma Program (DP) in the United States. It is vital to ensure that learners have well-trained educators and administrators who promote coaching, mentoring, supporting, and offering educational resources. At the point when IB set up the Diploma Program (IBDP) in 1968, its specific programme mission was to give worldwide schooling that would empower learners to more readily comprehend and deal with the complexities of our global reality and to furnish them with the abilities and mentalities to make a move to improve it (Dever & Raven, 2017; Kidson et al., 2019).

The IBO offers an international educational plan structure that joins components of top practice from a scope of global systems and educational programmes and urges learners to think about their international and local settings inside their learning scope (Dickson et al., 2017). The IBO works freely of governments and their compulsory educational programmes (Dickson et al., 2017). Notwithstanding, the IBPYP and IBMYP structures are intended to accommodate any public educational programme (Dickson et al., 2017). IB programmes give rounded learning by assisting learners with building up a feeling of empathy, societal commitment, and active learning (Dickson et al., 2017). They are urged to take their training past educational learning (Dickson et al., 2017). IB

programmes are intended to develop globally inclined learners, each with their learning difficulties, qualities, and styles (Dickson et al., 2017). In addition, IB programmes cultivate learners' psychological growth, including emotional, physical and social welfare (Dickson et al., 2017).

IB learning is inquiry-based and concept-driven, giving learners numerous advantages whenever executed well (Dickson et al., 2017). Inquiry-based education advances profound learning and engagement (Dickson et al., 2017). It encourages a motivating and challenging learning climate in which learners are esteemed in all achievement levels (Dickson et al., 2017). Pendergast, Dole and Rentoule (2014) analysed the discussion of learner experiences in an IBMYP and IBDP Mathematics lesson in an independent school. Their research reveals that each educator's chosen teaching methods are a significant contributing factor and determinant of learner involvement in schoolroom discussion. Therefore, as the scholars allude, the educator, not the curriculum, decides a learner's lesson experience proposing that teaching method workshops must be organised for specific educators for an effective change. The scholars point out that the educator and his teaching method are critical in deciding the learner's performance. There are gaps between the IBMYP and the IBDP, which affects learner experiences of the IBPYP-IBMYP-IBDP continuum (Walker et al., 2014).

Successful learning is a multi-faceted undertaking that needs educators and learners' energy in equal amounts (Holman et al., 2015). The relationship between educator efforts and learner results will eventually reveal the effectiveness of the school

in preparing learners to flourish educationally, first to acquire their secondary school diplomas, and lastly, their college degrees (Holman et al., 2015; Saavedra, 2014b; Sanders & Ishikura, 2018). It is not just the joint endeavours and commitment of the educator and learner that direct this excursion to progress, yet the transparent communication between the inspirations, philosophies and activities of the educator and learner, as two principal players (Holman et al., 2015). The most industrious learners are the ones that have an unmistakable vision about what they will do after secondary education and that learners' intellectual perseverance is invigorated by the alternatives they feel are accessible for them toward the finish of their secondary school education (Holman, Pascal, E. A., Bostan, Hoşbotă & Constantin, 2016). Therefore, IBDP educators need to clarify the significance of the IB-learner profile to learners' lives and the valuable abilities that a learner develops, just as the manners by which these abilities and attitudes could assist with propelling their schooling and professions (Holman et al., 2016).

Financial implications.

Admittance to IB schools in Australia is generally restricted to families who live in enormous urban areas and can afford to live in a community with high lodging costs or pay expenses to attend a non-public IB school (Dickson et al., 2017). Therefore, learners from lower economic status are underrepresented in Australian IB schools (Dickson et al., 2017).

Assessment.

The IB Organisation (IBO) works with global organisations, governments, and schools. Sanders and Ishikura (2018) investigated the relationship between the

admission reform, IBDP and government project development in Japan. They attest that the International Baccalaureate (IB) is a worldwide educational organisation that provides global assessment, curricula and programmes to schools around the planet. The IB Diploma Programme (IBDP) is the IB's first programme that was established in 1968 by global educators principally situated in Europe, even though it was at the same time presented at seven schools in five nations around the globe (International Baccalaureate Organisation, 2021c; Kidson et al., 2019; Sanders & Ishikura, 2018). The IBDP is a two-year college preparation programme for learners in upper secondary, offered in the last two years of secondary education (Dickson et al., 2017; Sanders & Ishikura, 2018). As of 2021, the IBDP was offered in over 3,659 schools (International Baccalaureate Organisation, 2021e) in 150 countries (Sanders & Ishikura, 2018).

Every year roughly 150,000 learners take end programme IBDP international assessments and graduate to be admitted to colleges/universities (Saavedra, 2014b; Sanders & Ishikura, 2018). As of 2021, the United Kingdom (UK), Canada and the United States of America (USA) have an enormous number of IBDP schools (Sanders & Ishikura, 2018). In addition, there is an extensive and increasing presence in Netherlands, India, and China (Sanders & Ishikura, 2018). The IB Organisation (IBO) works with global organisations, governments, and schools to create a rigorous assessment and international education programmes that are challenging (International Baccalaureate Organisation, 2021i; Wathall, 2016). These projects support learners worldwide to become lifelong, compassionate and active learners who comprehend that others, with

their disparities, can likewise be correct (International Baccalaureate Organisation, 2021i).

The IBDP is a varied blend of educational models that increases choices (USA model), gives profundity at a degree of first-year college learners (UK model), and incorporates significant sections of technology, sciences, and arts (French model) (Dickson et al., 2018; Saavedra, 2014b). Furthermore, the IBDP's recommended educational programme contains material concerning learning-content, as schools are offered self-governance to choose how the academic programme is executed (Dickson et al., 2018). In addition, the IBDP incorporates external assessment, for example, text response, essay, short response, and case study format items just as internal assessment, for example, artistic exhibitions, oral work, and field-work (Dickson et al., 2018).

IBDP examinations permit learners to comprehend their reasoning processes instead of the recitation of information, consequently empowering educators to cover a broad scope of themes and approaches inside the boundaries of the IBDP's recommended educational programme (Dickson et al., 2018). In addition, the size of assessment choices offered in the IB uses criterion-referenced summative and formative assessment to assess learners' abilities and knowledge of content (Dickson et al., 2018). Lee, Walker and Bryant (2018) Investigated practices in leadership related to International Baccalaureate (IB) learner-achievement. They observed that to encouraging educator improvement, development and learning are planned resourcing strategies that are clearly and positively related to International Baccalaureate (IB) exam scores.

Curriculum.

The IBDP has gained an excellent reputation for scholarly greatness in balancing breadth and specialisation (Dickson et al., 2018). Additionally, learning subjects through six curricular groups (humanities, Mathematics, experimental science, social science, a language that is learned, literature and language in a language in which the learner is currently fluent with), IBDP learners take on two extra obligatory components, Creativity-Activity-Service (CAS) and Theory of Knowledge (TOK), which assist in developing critical reasoning and research abilities (Aldana & Mayer, 2020; Dickson et al., 2018; Holman et al., 2015; International Baccalaureate Organization, 2021b; Lee et al., 2017). Finally, IBDP learners write an Extended Essay centred on a theme of their personal preference in their last year of study (Dickson et al., 2018; Holman et al., 2015; International Baccalaureate Organization, 2021b).

Learners and educators value the opportunity and autonomy offered by the IBDP for learners to explore their choices (Dickson et al., 2018). Learners report that the IBDP provides an educational programme that permits them to practice balanced education (Dickson et al., 2018). Holistically learning and inter-disciplinary instruction are the primary standards of all programmes in IB (Dickson et al., 2018). Holistically learning is the thought that all information is interconnected in an educational programme that builds up the individual entirely, and inter-disciplinary instruction is the cycle by which the learner comes to comprehend groups of information from at least two subjects and integrates them to make fresh comprehension (Dickson et al., 2018). Learners in old IBDP programmes could choose from three Mathematics courses, namely Mathematics

Higher-Level (HL) (includes Further Mathematics Higher-Level course), Mathematics Standard Level (SL), and Mathematical Studies (Handscombe, 2013).

Performance.

IB programmes are exceptionally respected partly because graduates typically have excellent academic achievement (Dickson et al., 2018). In addition, it is notable that IB learners are untypical (Dickson et al., 2018). They come from professional or higher middle-class families, as learners from these families, on average, have higher academic achievement than their companions from lower financial families (Dickson et al., 2018). In numerous secondary schools, the IBDP is a discriminatory programme confined to successful learners (Dickson et al., 2018). On the other hand, the IBDP might be offered to all learners at a given secondary school (Dickson et al., 2018). However, the school regularly serves successful learners from advantaged societal upbringings (Dickson et al., 2018).

The IBDP improved learner academic performance and accomplishment. Dickson, Perry, Ledger (2018) explored the effect of IB programmes on teaching-learning, featuring patterns, difficulties, and advantages. They found that college learners in the United Kingdom who studied the IBDP had high achievement grades in college than learners who had done A-levels, the old-fashioned root for college enrolment (Ateskan et al., 2015). The scholars accordingly forewarned that the predominant achievement of IBDP learners at British colleges is not the effect of IBDP however could instead be an image of IB learners' higher academic capacities contrasted with their non-IBDP colleagues

(Ateşkan et al., 2015; Dickson et al., 2018). Thus, the IBDP improved learners academic performance and accomplishment (Dickson et al., 2018).

Learners, educators and college administrators recognise that IB programmes are preparing learners well for college training and improve their chances of getting admitted to several colleges (Ateşkan et al., 2015; Dickson et al., 2018; Saavedra, 2014b; Saavedra, Lavore & Flores-Ivich, 2016; Sanders & Ishikura, 2018). Critical reasoning and creative abilities are noticeably highlighted among IB programmes (Aldana & Mayer, 2020; Dickson et al., 2018). In addition, IB programmes provide numerous prospects for psychological skills, for example, critical and creative intuition, to be inculcated among learners (Aldana & Mayer, 2020; Dickson et al., 2018; Lee et al., 2017).

IB urges learners to think independently and critically, make their inquiry, and use their knowledge gained to comprehend issues in their communities (Dickson et al., 2018; Lee et al., 2017). IB programmes also intend to build learners' local and worldwide social responsibility (citizenship) (Dickson et al., 2018; International Baccalaureate Organisation, 2021a). Citizenship is built in the IBDP by means of the Creativity-Activity-Service (CAS) component (Dickson et al., 2018; International Baccalaureate Organisation, 2021a). CAS calls for learners to attempt a voluntary and unpaid activity in their local communities (International Baccalaureate Organisation, 2021a). By and large, IB programmes urge learners to use their learning to comprehend worldwide and local problems (Dickson et al., 2018). IB anticipates that its approved programmes should advance worldwide citizenship, global mindedness, and inter-cultural comprehension

(Dickson et al., 2018). Clear objectives can be accomplished by discussing global problems and learning different cultures and languages (Dickson et al., 2018).

Instructional Strategies.

IB programmes depend on thinking (philosophy), where the learning process is concept-driven, learner-centred and inquiry-based (Dickson et al., 2018). Learners are viewed as knowledge-constructors, and the function of educators is to encourage learning instead of lecturing (Dickson et al., 2018). Therefore, educators are urged to utilise approaches that build learners' research aptitudes and critical reasoning abilities (Dickson et al., 2018). The reformist academic philosophy of the IB has been promoted as an expected method to encourage the advancement of 21st-century aptitudes while likewise giving adequate heaviness to the learning of essential school content (Wright et al., 2016).

IB Schools approval process.

A school wishing to become an authorised IB school should extensively go through a period of candidacy that demonstrates its alignment with the IB's philosophy, curricula, assessments, and prerequisites for IB administration support (Storz & Hoffman, 2018a). The process includes external reviews and staff development (Storz & Hoffman, 2018a). The required professional development incorporates involvement by certain educators at a workshop held at approved, well-performing IB schools (Storz & Hoffman, 2018a). Experienced IB organisation staff members facilitate the workshops, and educators and principals facilitate some within their school (Storz & Hoffman, 2018a). Even though the growth and development of the IBDP have roots in tuition-based schools, in many years, it has been embraced in an increasing number of state-funded schools globally (Beech

et al., 2018; Resnik, 2015). Beech, Guevara and del Monte (2018) examined the execution of the International Baccalaureate (IB) Diploma Program (DP) in state-funded schools in Argentina, Peru, and Costa Rica. They observed that contrasted with non-public schools, be that as it may, state schools in each of the three nations have lower Diploma pass-rates.

The three fundamental programmes of the IB organisation, otherwise known as the Geneva registered IB programmes, have developed significantly internationally over the previous decade, despite the programmes getting a warm welcome in the United States America (Bunnell, 2015). The IBDP gained considerable drive in the UK, particularly in state schools, around 2007 and was thriving in Britain in the past ten years (Bunnell, 2015). However, UK has experienced an unexpected drop in IBDP programmes (to emphasize, this is principally England) (Bunnell, 2015). The IBDP drops in the UK is directly inconsistent with the worldwide pattern. The absence of an increase of the IBDP in the UK has been astonishing, particularly in state schools (amongst Academies) (Bunnell, 2015). It seems that much depends upon financing changes as reports show that Ministers of education were thinking about amassing financing for the IBDP with an end goal to ensure that in-state schools the IBDP programme is not disturbed (Bunnell, 2015).

International Baccalaureate Career-Related Programme (IBCP) Schools

The IBPYP (for three to12-year-old learners), IBMYP (for 12 to16-year-old learners), IBDP (for 16 to 19-year-old learners), and IBCP (for 16 to 19-year-old learners) are offered by the International Baccalaureate Organization (IBO), an educational

organisation that is non-profit making established in 1968 (Dickson et al., 2017; Fitzgerald, 2015; Kidson et al., 2019; International Baccalaureate Organisation, 2021c). The IBDP was the initial programme offered among IB programmes (Dickson et al., 2017). The IBMYP and IBPYP were not offered until 25 years after the IBDP (1994 and 1997, respectively) (Dickson et al., 2017; International Baccalaureate Organisation, 2021c). The IBCP is the freshest IBO programme introduced in 2012 (Dickson et al., 2017). Each programme is independent of the other and can be taught in an independent format. Notwithstanding, the programmes collectively are intended to give an organised continuum of learning all through the early stages of a learner's education (Dickson et al., 2017). With the goal for schools to offer any of the four programmes, they should get approval from the IBO (Dickson et al., 2017).

The International Baccalaureate Career-related Programme (IBCP) was dispatched formally in 2012, a momentous achievement throughout the entire existence of the IB in that it looked to widen admittance to an IB schooling and bridge the scholastic/career-related gap (Dickson et al., 2017; Smith, Vehmas & Taurinolli, 2018). The improvement project that moulded the IBCP began in 2004 with a hidden plan rule that the programme would furnish a profession orientated route by combining it with comprehensive IB scholastic offers (Smith et al., 2018). The IBDP and IBCP are rigorous programmes of the IB organisation (Dickson et al., 2017; Wathall, 2016). The broadness of various learning routes the IBCP is motivating throughout the world shows that the adaptable IBCP programmes assimilate worldwide settings and support transformational educational encounters for a wide range of learners and communities (Smith et al., 2018).

There are 287 approved IBCP schools in more than 26 nations around the globe (International Baccalaureate Organization, 2021f; Smith et al., 2018). However, the current study is not comparatively investigating school-related resources as determinants of Mathematics achievement among IBCP learners. Instead, the study comparatively investigates school-related resources as determinants of Mathematics achievement among IBDP learners doing Mathematics AA courses in South Africa and Singapore.

Benefits of the International Baccalaureate Diploma Programme (IBDP)

University, admission requirement review, discovered that the IBDP is consistently and internationally recognised as a pre-college qualification, and United States of America (USA) universities grant IB graduates credits exemption for first-year courses (Ateşkan et al., 2015; Conley, McGaughy, Davis-Molin, Farkas & Fukuda, 2014; Dixon et al., 2014; Perna et al., 2015; Pilchen, Caspary & Woodworth, 2020; Saavedra, 2014b; UK-NARIC, 2017). Moreover, numerous IBDP learners apply to overseas colleges because they feel the IBDP prepared them well for international study (Saavedra, Lavore & Flores-Ivich, 2016; Sanders & Ishikura, 2018). In addition, IBDP Mathematics Higher Level (HL) covers topics on calculus very well. As a result, colleges find IBDP to be preparing and giving learners a strong base in Mathematics as well as H2 Mathematics of Singapore and A-level Mathematics of UK (Alcántara, 2016; Ateşkan et al., 2015; Perna et al., 2015; Pilchen et al., 2020; Saavedra, 2014b; Saavedra, Lavore & Flores-Ivich, 2016; Sanders & Ishikura, 2018).

IBDP incorporates technology with Mathematics (Alcantara, 2016). IBDP further Mathematics Higher Level was the most mentally challenging course compared with H3

Mathematics of Singapore and GCE A-level Further Mathematics (Alcántara, 2016; Faas, 2014). Concerning evaluation, the IBDP and GCE A-level give credit to precise strategies utilised, which is a far-reaching benefit in showing learner understanding (Alcantara, 2016). Furthermore, the IBDP subjects permit the most comprehensive level of grade differentiation in learner performance (Alcantara, 2016). As far as extra-curricular activities are concerned, learners doing IBDP courses would generally take an interest in more afternoon activities than non-IBDP learners (Aldana & Mayer, 2017). Contrasting the full IBDP with non-IBDP learners, partial and full IBDP learners are likelier to engage better in schoolroom encounters (Aldana & Mayer, 2017; Holman et al., 2015; IB Global Policy & Research Team & Center for Evaluation and Education Policy, 2010).

Both full and partial IBDP learners were significantly bound to view their schoolrooms as vigorous contrasted with their non-IBDP cohorts (Aldana & Mayer, 2017; Coca, Johnson, Kelley-Kemple, Roderick, Moeller, Williams & Moragne, 2012; IB Global Policy & Research Team & Center for Evaluation and Education Policy, 2010). In addition, partial and full IBDP learners would generally view their secondary schools' going culture more positively when compared to their non-IBDP peers (Aldana & Mayer, 2017; IB Global Policy & Research Team & Center for Evaluation and Education Policy, 2010). Furthermore, partial and full IBDP learners were bound to have school-support advisers from their secondary schools than non-IBDP learners, implying that learners doing an IBDP programme would generally have more comprehensive counsel and assistance in school (Aldana & Mayer, 2017). Finally, educational achievement objectives for learners doing IBDP were bound to be higher than their non-IBDP peers (Aldana & Mayer, 2017;

Holman et al., 2015; IB Global Policy & Research Team & Center for Evaluation and Education Policy, 2010).

Learners in IBDP programmes report that their educators and advisors are both demanding and encouraging at the same time (Aldana & Mayer, 2017). The IBDP has a standing of being demanding and wealthy in content permitting learners to complete studies in an international college (Dixon, Charles, Moss, Hubber & Pitt, 2014; Faas, 2015; Fitzgerald, 2015; Halic, 2013; Perna et al., 2015; Pilchen et al., 2020; Saavedra, 2014b; Saavedra, Lavore & Flores-Ivich, 2016; Sanders & Ishikura, 2018). Colleges have acknowledged that the IBDP gives an appropriate readiness to college studies that are here and there better than A-level (Handscombe, 2013; Perna et al., 2015; Pilchen et al., 2020; Saavedra, 2014b; Saavedra, Lavore & Flores-Ivich, 2016; Sanders & Ishikura, 2018). IBDP learners highlighted the scholastic rigorousness of the IBDP and supportive educators and principals as positively influencing their secondary school experiences and readiness for university (Aldana & Mayer, 2020; Wathall, 2016).

The IBDP educational programme was a more considerable global core interest (Dixon, Charles, Moss, Hubber, Pitt, 2014). IBDP learners value their educators' higher personal and academic expectations (Aldana & Mayer, 2017). IBDP educators appear to be eager to invest energy outside of the school day to give additional assistance to their learners (Aldana & Mayer, 2017). IBDP educators assist learners in defeating individual deterrents by telling their own experiences and re-directing learners' attention from the current conditions to a superior or better future (Aldana & Mayer, 2017). IBDP learners likewise shared that their educators inspire them (Aldana & Mayer, 2017). A more

elevated level of commitment to studies causes learners and educators to feel spurred (Barnett, Tokuhama-Espinosa, Rivera, Montero & Palacios, 2013; Halic, 2013).

IBDP learners are interested in a wide assortment of sporting and extracurricular activities (Aldana & Mayer, 2017). These undertakings appeared to furnish learners with extra peer-drove and educator-led support structures and gave learners a feeling of good self-esteem (Aldana & Mayer, 2017). Learners likewise made significant relations between their extracurricular activities and better achievement in their schoolwork (Aldana & Mayer, 2017). IBDP learners portrayed an inclination of a solid feeling of having a place in their school that they ascribed to their educators and peers and their participation in the IBDP (Aldana & Mayer, 2017). Ultimately, IBDP learners and IBDP graduated class exhibit numerous characteristics of scholarly resilience (Aldana & Mayer, 2017).

IBDP learners have a preferred position over non-IBDP learners as to the utilisation of English (both in written tasks and the schoolroom), and other scholastic abilities learnt up during secondary school applicable to college courses (Ateşkan et al., 2015; Dixon et al., 2014; Holman et al., 2015; Perna et al., 2015; Pilchen et al., 2020; Saavedra, 2014b; Sanders & Ishikura, 2018). IBDP graduated class also revealed feeling equipped for the free-response and essay tasks they experienced at college (Ateşkan et al., 2015; Conley et al., 2014). The IBDP is a demanding educational programme that prepares learners better for college is socially and verbosely built (Aldana & Mayer, 2020; Fitzgerald, 2015; Halic, 2013; Perna et al., 2015; Pilchen et al., 2020; Saavedra, 2014b; Saavedra et al., 2016; Sanders & Ishikura, 2018).

The instructional method offered in the IBDP is perceptibly different from that in the non-IBDP schoolrooms (Barnett et al., 2013). As a rule, IBDP learners are offered efficient, inventive lessons with continuous learner educator communication (Barnett et al., 2013). They are unmistakably dynamic about their learning, ready to think adroitly and communicate well (Barnett et al., 2013; Coca et al., 2012). The IBDP seems, by all accounts, to be profoundly affecting state education in Ecuador. Numerous learners pick up, and innumerable educators develop as experts (Barnett et al., 2013).

Moreover, IBDP gives structures that make groups that are supportive for learners that can be continued over a long period (Barnett et al., 2017; Dixon et al., 2014)—for instance, doling out learners to schoolrooms toward the start of their secondary school with a lead educator who remains with the learner group until completion (Barnett et al., 2017). The lead educator would then monitor how each learner is getting along both scholastically and socially, and if required, can intervene (Barnett et al., 2017).

The IBDP provides staff resources to learners (for example, psychologists, social workers, and guidance counsellors) to handle assignments in IBDP that are more challenging (Barnett et al., 2017; Faas, 2014). Learners and their educators in IBDP schools can access a Wi-Fi internet, and almost all IBDP schools do not reserve their Wi-Fi internet solely for educators (Cooker, Crook & Ainsworth, 2015a). Over 80 per cent of IBDP schools utilise a learning management system (LMS) or course-management software (CMS) or virtual-learning-environment (VLE) (Cooker et al., 2015a). To be specific, IBDP schools mentioned the utilisation of 12 different systems, where ManageBac and Moodle were used by most schools (Cooker, Crook, et al., 2015a).

The IBDP Programmes guarantee hoist learners' status with certifications to advance postsecondary achievement and professional success (Donovan & Lakes, 2017). In addition, colleges have acknowledged that the IBDP gives an appropriate readiness to college studies that are here and there better than A-level (Aldana & Mayer, 2020; Handscombe, 2013; Perna et al., 2015; Pilchen et al., 2020; Saavedra, 2014b; Saavedra et al., 2016; Sanders & Ishikura, 2018). For example, in Mathematics, a pass with A at A-level equals level 4 or 5 at IBDP higher level, and a pass with A* at A-level is equivalent to level 6 at IBDP Higher Level (HL) (Handscombe, 2013).

The IBDP is wanted like never before, and it can utilise its favoured spot to merge a function as one of the leading promoters of global standards in worldwide learning (Haywood, 2018). The IBDP learners contrast nicely with A-level learners at colleges in the United Kingdom (Higher Education Statistics Agency (HESA), 2016). Research shows that IBDP learners were significantly more likely than their A-level companions to be admitted by the top 20 colleges in the United Kingdom (Higher Education Statistics Agency (HESA), 2016). Furthermore, IBDP learners have a significantly better probability of receiving a top-grade pass-rate in honours degrees than A-level learners (Higher Education Statistics Agency (HESA), 2016). A-level learners, nonetheless, were almost sure that IBDP learners to take Science, Technology, Engineering, and Mathematics (STEM) courses in the first year of their college studies (Higher Education Statistics Agency (HESA), 2016; Sanders & Ishikura, 2018).

IBDP learners are significantly bound to be occupied with advanced studies after graduating from college (HESA), 2016). In contrast, A-level learners were bound to join

the labour force considerably without considering advancing their studies (Higher Education Statistics Agency (HESA), 2016). In addition, the IB programmes encourage the educator-learner process of correspondence to a more significant level, just as the educators' professional development (PD), through PD workshops (Holman et al., 2015). At the global level, correspondence among educators and support staff is more translucent than in the old-style system of education (Holman et al., 2015). Thus, IBDP learners do not just build up a solid structure to move toward acquiring new knowledge from different study areas (Holman et al., 2015). Yet, they likewise build up the capacity to design ahead of time and deal with significant tasks throughout an upsetting timeframe (Holman et al., 2015).

The learning processes are more than retaining concepts and getting good grades (Holman et al., 2015). It is likewise about self-development and cultivating capacities that permit learners to adjust well to any situation (Holman et al., 2015). Contrasted with non-IBDP learners, IBDP learners generally have high scholastic aptitude test (SAT) marks and secondary school grade point averages (GPAs) (Aldana & Mayer, 2020). IB cultivates an extensive and assorted range of abilities that seemingly surpass AP's essential strategy for testing for knowledge recall (Larson & Kurtyka, 2017; Perna et al., 2015). Courses in the IBDP give a rich base and foundation to learners who finish the whole IBDP programme (Larson & Kurtyka, 2017). Resnik (2019) conducted a study that analysed the IB Diploma – Higher Education admission in the United States of America, Spain, Chile, Canada, and Argentina. The IBDP is being introduced in an expanding

number of independent and public schools. Thus, transforming the IBDP into a worldwide education influence.

Colleges in Canada are stumbling over one another, attempting to allure IBDP learners to attend their colleges, offering them advantages (Pilchen et al., 2020; Saira, 2017). For example, full credit transfer offered to IBDP graduates, offered special scholarship grants, prioritised course-enrolments, and offered first preference in selecting rooms in residences (Pilchen et al., 2020; Saira, 2017). The IBDP programme not just yields learners who shine scholastically and socially yet additionally ensures retaining and degree achievement and that IBDP learners get the most lucrative positions after college completion (Pilchen et al., 2020; Saira, 2017). After three years of college/university education, 62 per cent of IBDP alumni procured a four-year college degree, contrasted with 41 per cent of all United States of America learners (Pilchen et al., 2020).

About the Swedish curriculum, the IBDP covers a significant extent of Sweden educational curriculum and incorporates extra important curriculum material (UK-NARIC, 2018). Furthermore, the IBDP assessment shows expected knowledge comparison to the Swedish curriculum prerequisites (UK-NARIC, 2018). The level of the IBDP content and Sweden educational curriculum indicates that IB-world schools in Sweden are well prepared to teach the IBDP in a well-matched manner with the principal curriculum, goals, aims, and assessment expected in Sweden system of education (UK-NARIC, 2018). The IBDP gives a more extensive broadness of knowledge about the Norwegian curriculum, and both curricula build comparable capabilities and content information (UK-NARIC, 2019).

The curriculum alignment demonstrates that Norwegian IB-world schools are well prepared to teach the IBDP in a well-matched manner with the principal curriculum, goals, aims, and assessment expected in the Norway system of education (UK-NARIC, 2019). Therefore, the IBDP has positive results and difficulties (Valle, Menéndez, Thoilliez, Garrido, Rappoport & Manso, 2017). Generally, the IBDP is assumed to produce positive results, incorporate a beneficial move in school atmosphere and culture, adjust teaching-learning methodologies, and improve specific capabilities in learners (Valle et al., 2017).

Challenges of the International Baccalaureate Diploma Programme (IBDP)

Turkish universities and colleges do not recognise the IBDP alone for admission (Ateskan, Onur, Sagun, Sands & Corlu, 2015). Hence, in Turkish IBDP schools, the IBDP and Ministry of Education National Education Programme (MoNEP) are instructed simultaneously (Ateskan et al., 2015). As a result, numerous colleges or universities appear to underrate or underestimate the IBDP programmes (Bunnell, 2015). Also, the IBDP is an intentionally difficult system of education yet, at the same time, undervalued (Bunnell, 2015). Another challenge with IBDP could be that all learners do not equally meet the admission standards for qualified IBDP learners (Perna et al., 2015; Saavedra, 2014b). Learners from more privileged families regularly dominate the IBDP schoolrooms and opportunities (Perna et al., 2015). High educator workloads and the low equivalence of the IBDP's assessment and grading system with that of the Ministry of Education was found to be a key challenge with the execution of the IBDP in public schools in Spain (Valle et al., 2017). Another noted challenge is access and equity in Spanish state schools (Valle et al., 2017).

International Baccalaureate (IB) in Africa

Starting from 2015 rolling back to the 1970s, IBDP authorisation in the African region: in 2015 was Gabon, 2013 was Madagascar, 2007 was Sudan, 2005 ware Rwanda and Mozambique, 2004 were Zimbabwe and Nigeria, 2001 were Botswana and Angola, 2000 were Tunisia and Senegal, 1998 was Namibia, 1997 was Malawi, 1996 was Zambia, 1995 was Uganda, 1994 were Togo and South Africa, 1993 were Mauritius and Ghana, 1989 was Egypt, 1986 were Morocco and Lesotho, 1982 was Kenya, 1979 was Eswatini (Swaziland), and 1977 was Tanzania (Bunnell, 2016). The first African IBDP school authorised in January 1977 is International School Moshi (Tanzania) (Bunnell, 2016). The school in Moshi had joined the Ibadan school, and in October 1979, was trailed by Waterford Kamhlaba United World College of Southern Africa (Eswatini) (Bunnell, 2016). By 2021, the IB organisation had authorised 121 IB world schools in 33 countries (International Baccalaureate Organisation, 2021l). Africa is the only continent with no public school offering the IBDP (Hill, 2018). However, two public schools in Egypt are funded by two non-public IB schools (Hill, 2018).

Benefits of the International Baccalaureate (IB) Curriculum.

Tallying to the advantages of IB training, the IBDP is an assurance of value and genuineness for African learners when applying to colleges (Aldana & Mayer, 2020; Ateşkan et al., 2015; Hill, 2018; Pilchen et al., 2020; Saavedra, 2014b). However, some school-exit qualifications do not carry quality training due to the massive size of classes in state-funded schools, shortage of resources, and ill-prepared educators (Hill, 2018). In addition, education authorities and schools in some cases consider that IB educational

programmes are excessively Westernised, even though enhancements have been made to incorporate Africa-based literature for language subjects, African sayings in the IBDP's Theory-of-Knowledge (TOK), and an Africa-based history choice at HL has been offered for a long time (Hill, 2018; Holman et al., 2015). However, the legacy of the colonial stays a key influencer, with British (Cambridge) and French educational programmes (French bac) dominating the marketplace (Hill, 2018). The French Ministry of Education provides monetary benefits, for example, sponsorships per capita of learners and payments of educators' remunerations for programmes in French (Hill, 2018).

Challenges of the International Baccalaureate (IB) Curriculum.

Offering IB programmes in public schools, in Africa seems to be a big challenge (Hill, 2018). In a few African countries, there are a small bunch of 'tip-top' public schools with suitable class sizes, excellent educators, and no educational expenses (Hill, 2018). However, a small fraction of public schools have class sizes, including the final year of school, which can be from 60 to 90 learners with no accessibility to textbooks and stationery (Hill, 2018). Moreover, the public schools have few educators taking teaching jobs because remunerations have not been paid for a while (Hill, 2018). Furthermore, IB programme execution is excessively costly in the more significant part of Africa. For example, the instability of some important currencies, for example, the South African Rand, Ghanaian Cedi, and Nigerian Naira, makes it hard to budget and set aside funds (Hill, 2018). On the other hand, the significant expense of in-person professional development (PD) has been lightened for English schools by getting into online training

(Hill, 2018). However, for French schools, the expense of sending educators to professional-development training for the IBDP, for instance, is a challenge (Hill, 2018).

Tallying to the cost challenge, African educators experience challenges acquiring visas to go to PD training outside their countries (Hill, 2018). Increase, and college admission is sometimes declined because the IBDP is not taught in the instruction language of the college (Hill, 2018). These are public colleges in North Africa, that lecture mainly in Arabic (including the Middle East) (Hill, 2018). In Sub-Saharan nation-states, college training can be afflicted with educators or learners generally protesting because remunerations and stipends are unpaid or paid with deferrals of a while (Hill, 2018). So IBDP graduates usually go to the USA or Europe except for Mauritius, Ghana, and South Africa, where colleges work well and admit IBDP alumni (Aldana & Mayer, 2020; Hill, 2018). All colleges do not entirely comprehend the IB, and it is viewed as a rivalry for nation-state examinations (Hill, 2018; Pilchen et al., 2020).

Progress so far in the introduction of the International Baccalaureate (IB) Curriculum.

Currently, two state IBPYP schools are beginning in 2017 in Egypt (Hill, 2018). Ministries of education have financed learners to do the IBDP in Eswatini, Lesotho, Nigeria, and Botswana (Hill, 2018). Partnership with establishments like Enko Education is increasing IBDP spread over the mainland, especially in nations like Senegal, Cameroon, and Mozambique, where Enko Schools exist (Hill, 2018). For example, relationships with major partners, the National Accreditation Board (Ghana), Higher Education South Africa, and the Association of African Universities have fortified IB's

recognition (Hill, 2018). Universities and governments in South Africa, Ethiopia, Ghana, and other countries have renewed approval statements for IB (Hill, 2018). The IB Africa site was launched, and the position of IB Manager for Africa was opened in 2012 to give IB existence on Africa's mainland (Hill, 2018). The IB utilises the help of alumni, acknowledgement envoys, and educators over the landmass to advance the IB in their specific circumstances (Hill, 2018).

International Baccalaureate (IB) in Asia-Pacific

IB-world schools in Asia-Pacific have been the quickest increasing sub-set of non-public schools across various regions (Lee et al., 2018). The absence of IB presence in Africa was not purposeful (Bunnell, 2016). The IB had initially made a decent attempt to work up interest in the undertaking in Africa (Bunnell, 2016). In an early missionary tour, the head and representative of the International School of Geneva, Robert Leach, in 1961-1962 visited schools in Europe, Africa, and Asia (Bunnell, 2016). In Pakistan, the four standards of the national education programme for Mathematics are also embodied in the IBDP, except for Geometry and Measurements. Just a portion of the benchmarks is incorporated in the IBDP (UK-NARIC, 2017). Otherwise, in both programmes, critical topics in Mathematics are canvassed, and both educational programmes are of a comparative profundity and broadness (UK-NARIC, 2017).

The International Baccalaureate (IB) has become a ground-breaking instructive brand by building upstanding for consolidating reformist methodologies with scholastic thoroughness (Wright et al., 2016). The thoroughness can be recognised by the increasing number of schools embracing IB programmes worldwide, particularly in the IB

Asia-Pacific (Wright et al., 2016). As a component of this pattern, the IB Middle Years Program (IBMYP), focused on learners in the range of 11 to 16 years old, has increased altogether as of late (Wright et al., 2016). Notwithstanding, the IBMYP is less well known in Asia-Pacific than the IBPYP and pre-college Diploma Programme, the International Baccalaureate Diploma Programme (IBDP) (Wright et al., 2016).

In Australia, the IBDP educational programme usually provides more prominent profundity than other local options and upholds the development of critical abilities and knowledge (Dixon et al., 2014). Most educators accepted that the IBDP is more meticulous and gives better college-study preparations (Dixon et al., 2014). However, the current study is not comparatively investigating school-related resources as determinants of Mathematics achievement among IB learners in Asia-Pacific. The study comparatively investigates school-related resources as determinants of Mathematics achievement among IBDP learners doing Mathematics AA courses in South Africa and Singapore.

International Baccalaureate (IB) in South Africa

Reasoma High School is a public school in the municipality of Soweto, close to Johannesburg, that is respected for producing the best matric results when contrasted with former non-white schools in South Africa (Bunnell, 2016). The government school tried to introduce IB programmes and sent its educators to IB workshops in Eastern Europe (Bunnell, 2016). However, the Gauteng provincial government encountered political challenges in authorising the IB programmes in the school, even with outside benefactor financing (Bunnell, 2016). As a result, South Africa had the first IB-world school in 1994 (International Baccalaureate Organisation, 2021k).

South Africa may have more disappointments than other African countries when establishing IB-world schools in its soils (Bunnell, 2016). The American International School of Johannesburg (AISJ) is the first IB-world school in South Africa, approved in 1994; however, it has since been joined by only nine IB-world schools (Bunnell, 2016; International Baccalaureate Organisation, 2021g). One of the identified reasons for South Africa to have fewer IB-world schools in the post-apartheid time beginning in 1994 is that the accentuation on tolerance put by the IB philosophy, as especially demonstrated in the IB Learner-Profile through the characteristics and learning result portrayed as 'balanced' may be a counter-power to managing violent behaviour in schools of South Africa (Bunnell, 2016).

In South Africa, the International Baccalaureate Organisation (IBO) in September 2013 approved The Oprah Winfrey Leadership Academy for Girls to offer the IBMYP (Bunnell, 2016). Therefore, one concurs with Bunnell (2016) that the absence of IB-world schools in Africa deserves clarification and research consideration. However, the current study is not comparatively investigating school-related resources as determinants of Mathematics achievement among IB learners in South Africa. Instead, the study comparatively investigates school-related resources as determinants of Mathematics achievement among IBDP learners doing Mathematics AA courses in South Africa and Singapore.

International Baccalaureate (IB) in Singapore

Singapore had the first IB-world school in 1977 (International Baccalaureate Organisation, 2021j). In the November 2016 IBDP external examinations, out of 94

perfect scorers (learners who scored 45 maximum points), 57 learners were from Singapore (Sin & Straits, 2017). The high number of perfect scorers made Singapore the highest performer (number one) in Asia-Pacific for seven successive years in IBDP external examinations (Sin & Straits, 2017). The international pass rate in November 2016 IBDP external examinations was 70.0%, while that of Singapore IBDP learners was 97.3% pass rate (Sin & Straits, 2017). In 45-point scores, Singapore had an average of 38.3 points, while the global score was 29.2 points (Sin & Straits, 2017). In November 2019, for IBDP external examinations, with a total of 45 points scores, Singapore had an average of 38.0 points, while the global score was 28.5 points, and Asia-Pacific was 33.9 points (Ang, 2020).

The international pass rate in November 2019 IBDP external examinations was 70.0%, while that of Asia-Pacific was 87.8%, and that of Singapore IBDP learners was 96.7% pass rate (Ang, 2020). It was noted that Singapore had 35 of the 69 perfect scorers recorded internationally (Ang, 2020). Singaporean IBDP schools produce a high number of 45 scores, and 40 or more get learners to numerous great colleges, similar to the Ivy League colleges in the United States of America (Teng, 2019). The reason why Singaporean IBDP schools produce the best results in IBDP external examinations is that IBDP schools in Singapore offer spaces in IBDP to learners coming with the best marks from lower grades (Teng, 2019).

Another reason is that in these IBDP schools in Singapore, the financial status of learners will generally be more fabulous, implying that there is also an impact of more home support and educational costs (Teng, 2019). However, the current study is not

comparatively investigating school-related resources as determinants of Mathematics achievement among IB learners in Singapore. The availability and upkeep of facility and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. Therefore, the study comparatively investigates school-related resources as determinants of Mathematics achievement among IBDP learners doing Mathematics AA courses in South Africa and Singapore.

School-related Resource Availability, Accessibility, and Utilisation

Technologies for Teaching-learning Resources

The current study is anchored and informed by the first stage of Maslow's hierarchy of needs. The next physiological needs to be explored concerning achievement in Mathematics under school-related resources are technologies for teaching-learning resources. Teaching-learning resources are imperative in the academic field and should be integrated into the lesson to attain the best achievement. Teaching-learning resources are a subset of instructive technologies (Okori & Jerry, 2017). That implies that there should be a transparent integration approach of technologies in the lesson whenever we talk about teaching and learning. Teaching and learning resources are defined by Okori and Jerry (2017) as various sorts of materials or media that educators and learners utilise in the teaching-learning process to make it more successful and profitable.

The teaching-learning resources assist educators in teaching successfully and empower the learners to learn all the more promptly. The support for educators raises the importance of teaching-learning resources in teaching Mathematics. In this setting,

resources are conceptualised as gadgets utilised to give the most extravagant conceivable learning climate, which helps the educators and learners accomplish an explicit goal in the briefest possible time (Okori & Jerry, 2017). Again, resources should prove to be a vehicle for imparting concepts in the minds of learners. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement. Next, the researcher presents the importance of technology in teaching-learning practices.

Technologies can help reach top achievement or poor performance depending on how they are utilised in a lesson. Therefore, the utilisation of technology is a vital component of the scholastic achievement of learners (Costa et al., 2020). The importance of technology changes the whole dynamic of 21st-century schoolroom practices. The scholars emphasise that technology is an instrument that guarantees that the globe is connected and further assists learners in raising their level of self-confidence. Stohlmann and Acquah (2019) conducted an investigation from 2010 to 2019 to find the influence of technology in teaching Mathematics. The scholars found that technological developments can change how Mathematics is imparted by improving effective teaching-learning practice—indicating that technology can be used as a vehicle for transmitting academic information. However, Giunchiglia, Zeni, Gobbi, Bignotti and Bison (2018b) and Halpern, Pina and Ortega-Gunckel (2020) contend that ICT increases the probability of being distracted and performing multiple tasks, which negatively affects educational achievement.

The negative impact of technology shows that technology should not be used indiscriminately. It has to be controlled. Gubbels, Swart and Groen (2020) examined the accessibility of digital resources, learners' utilisation of those resources, and learners' mentalities toward digital resources. They have demonstrated that moderate accessibility and utilisation of digital devices positively affect Dutch learners' electronically assessed reading achievement. However, they indicate that technology does not always give positive outcomes in all subjects and nations. The availability and upkeep of facility and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. Hence, this study is needed to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the current research framework, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement. Next, the researcher discusses technology platforms that are open and accessible in the field of education.

The technological platforms used in teaching and learning are important for academic achievement. Johns, Troncale, Trucks, Calhoun and Alvidrez (2017) claim that different technology platforms, such as Facebook, websites, and social media, could effectively enhance learner engagement in teaching and learning. Social media allows educators to plan a learner-dynamic learning approach (Johns et al., 2017; Stohlmann & Acquah, 2019). Classtools.net is a non-fee webpage, state Johns, Troncale, Trucks,

Calhoun and Alvidrez (2017) permit clients to customise numerous news-based and social platforms. The scholars add that clients can select to compose charts and puzzles, word-generators, Twitter feed, main newspaper headlines, and their breaking news alert layouts.

Another instrument accessible on Classtools.net is Fakebook, another version of Facebook that permits the client to add pictures or recordings, show associations with others, make a character, and create posts and remarks timelines (Johns et al., 2017). The scholars maintain that the Fakebook-page configuration can be a collaborative or individual venture that stresses the profound examination. Research shows that Fakebook allows learners to engage interactively in the technologically driven world both currently and later on (Gain & Ancho, 2019; Johns et al., 2017; McMeans, 2015). Johns, Troncale, Trucks, Calhoun and Alvidrez (2017) reiterate that the technologically driven utilises the nuts and bolts of Facebook to advance learning.

Fakebook is effective, concede the scholars, draws learners in, and is a safe instrument that offers an elective way to deal with the assessment, presentation, and instruction in any schoolroom. However, if IBDP schools could use these technologies to teach Mathematics AA (Analyses and Approaches), a question remains. Hence, there was a need for research to comparatively investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

Next, the researcher discusses Google Classroom as a tool used in education to enhance teaching-learning achievement.

The Google Classroom is another instrument used by educators in the academic field. As more innovation comes into the schoolroom, educators need to find new and different methods to incorporate these tools into the educational plan (Johns et al., 2017). The Google Classroom is one of the creative instruments rapidly rising in attractiveness in the education field (Johns et al., 2017). The Google Classroom platform permits educators to utilise digital devices to maximise learners' learning and efficiently manage schoolrooms (Johns et al., 2017). In addition, educators could interactively utilise this platform to assist in managing the running of their schoolrooms (Gain & Ancho, 2019; Johns et al., 2017).

Educators can flip their schoolroom, a procedure where the learners create, investigate, and assist with driving their learning (Cummings, 2016; Johns et al., 2017). By utilising Google Classroom, educators can enable their learners to take responsibility for their learning (Johns et al., 2017). Numerous schoolroom motivation-engagement problems originate from learners being less motivated or bored (Costa et al., 2020; Johns et al., 2017). Exploration is needed to deduce if the tool affects IBDP Mathematics AA in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement. Next, the researcher discusses other interactive tools useful in education, like the Educreations application and the Seesaw.

Interactive tools like the Educreations application and the Seesaw come in very handy in the teaching fraternity. Educators can utilise a smartboard or interactive whiteboard and screen-casting devices to enable learners to take responsibility for learning through collective project-oriented learning undertakings (Gain & Ancho, 2019; Johns et al., 2017). An application that fills in as an interactive whiteboard and screen-casting is the Educreations app, through which clients can add a recording, voice-over, picture, and annotation to a teaching presentation in an effort to clarify an idea or thought (Costa et al., 2020; Johns et al., 2017). For the learners to annotate and draw, the computer-generated whiteboard incorporates an assortment of ink tones (Johns et al., 2017). The application is anything but difficult to utilise and permits educators and learners to make recordings, craft presentations, and outline thoughts (Johns et al., 2017).

Educators usually utilise the Educreations application (https://www.educreations.com/) to form instructions in a flipped schoolroom climate or with the end goal of distance teaching-learning (Costa et al., 2020; Johns et al., 2017). Moreover, while Educreations benefits educators by looking for devices that facilitate teaching-learning and allowing learners to create procedures for making and exhibiting capability in their learning goals (Johns et al., 2017), for example, in a Mathematics schoolroom, learners can utilise education application to make videos clarifying the means they took to reach a solution of a given task (Costa et al., 2020; Johns et al., 2017). Another helpful technological tool in the schoolroom is a Seesaw (https://web.seesaw.me/) (Johns et al., 2017). A Seesaw is a learner-driven

computerised portfolio that gives a protected and private space to retain learners' tasks and undertakings shared with guardians (Johns et al., 2017).

Learners can upload photographs, recordings, PDFs, text drawings, text PDFs, and links to show what they have learned (Johns et al., 2017). The availability and upkeep of facility and learning resources were featured in Juta & Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. However, the question remains if these tools influence achievement in the teaching and learning of IBDP Mathematics AA in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement. Next, the researcher discusses the Seesaw learning platform in education.

Any technological tool, when wrongly used, might yield negative results. Therefore, the seesaw is one of the tools which is useful when properly used in education. An educator can make computerised portfolios for learners, suggest Johns, Troncale, Trucks, Calhoun and Alvidrez (2017), by following basic steps. Initially, clarify the scholars; educators create their individual Seesaw accounts. They will then create a class, add learners, and configure the settings of the different courses (Johns et al., 2017). Johns, Troncale, Trucks, Calhoun and Alvidrez (2017) emphasise that the educators decide who can see the learner’s work, for example, colleagues of the learner and guardians, and whether to permit them to ‘like’ or make comments on other learners’ posted tasks (Johns et al., 2017). The Seesaw webpage is a resource for educators to

set up their first class; parent introduction presentations and letters, the Seesaw learner challenge, checklist, and the getting started calendar are a few resources accessible for educators (Johns et al., 2017).

Seesaw Learner Challenge is an introduction plan for the lesson intended to permit learners to gain proficiency with the nuts and bolts of the electronic journal, utilising drawing tools, recording a video, taking photographs, signing in, taking care of gadgets, and offering criticism to schoolmates (Johns et al., 2017). The Seesaw application engages learners, resulting in learners owning their learning (Costa et al., 2020; Johns et al., 2017). Parents and learners can download Seesaw's Parent Application for Android or iOS gadgets or utilise the Website to see artefacts for learning, and guardians can see portfolios just for their child and schoolroom things that educator posts on everybody (Johns et al., 2017). Seesaw, along these lines, believe Johns, Troncale, Trucks, Calhoun and Alvidrez (2017), give a straightforward and fast path for an educator to convey and update every learner's advancement with their guardians. This application also permits guardians to provide their children’s artefacts (Johns et al., 2017).

To conclude, Seesaw's computerised portfolio is a simple method to advise guardians regarding schoolroom exercises and give more chances for parents to partake in their children’s schooling (Johns et al., 2017). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. We still need to know if Seesaw enhances achievement in IBDP Mathematics AA in South Africa and Singapore. According to the framework of the current

study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement. Next, the researcher presents some important learning principles learners should go through.

For good experience in the teaching-learning practice in the schoolroom, learners ought to be exposed to essential learning principles. The following are some principles that are useful if considered when planning schoolroom engagement: Learners ought to be given more opportunities to do collaborative tasks; Learners ought to be given prompt and clear constructive criticism; Learning tasks ought to be meaningful and well-organised; Learners ought to be given an opportunity to make choices; Educators ought to endeavour to create a learning environment in which the objectives and teaching intentions are spoken to learners (Johns et al., 2017; Turner, Christensen, Kackar-Cam, Trucano, & Fulmer, 2014). These principles are essentially a beginning stage for educators. However, they can be tended to with the technological applications mentioned in this section(Costa et al., 2020; Johns et al., 2017). In addition, the Internet needs to be accessed in all schoolrooms so the utilisation of laptop computers can be incorporated into lessons (Superville, 2017).

The utilisation of ICT has been a significant aspect of Mathematics and the interdisciplinary gaining of competencies (Superville, 2017). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research confirms whether these learning principles

enhance achievement in IBDP Mathematics AA in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement. Next, the researcher discusses that PCs and ICT material resources utilisation correlate with good achievement and poor performance in learners.

PCs and ICT material resources utilisation correlates with good achievement and poor performance in learners. The assessment of IT-material problems in 2003-2012 at the OECD examination in secondary schools indicates that in numerous countries analysed; there are significant teaching limitations brought about by a need or deficiency of PC material (Eickelmann et al., 2017). Notwithstanding the importance of IT material for schools to support PC-based teaching-learning methods, the assumption cannot be made that the amount of ICT resources in schools is helpful (Eickelmann et al., 2017; Stoddard, 2014). Numerous studies consulted indicate that it is rather the alignment of the pedagogy of the accessible IT material with the instructive objectives just as the integration into Mathematics learning methods that matters (Costa et al., 2020; Eickelmann et al., 2017; Gain & Ancho, 2019; Stohlmann & Acquah, 2019).

A positive relationship exists between the performance and the availability of PCs at school. Results from the IEA investigation of TIMSS 2003 indicated that performance in Mathematics in all participating countries was positively related to the utilisation of PCs both at home and at school by learners (Eickelmann et al., 2017). However, Eickelmann, Gerick and Koop (2017) contend that more continuous and frequent ICT utilisation at

school correlates with lower performance (Eickelmann et al., 2017). The availability and upkeep of facility resources and learning resources were featured in Juta & Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research will indicate whether PCs and ICT school-related resources determine mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement. Next, the researcher discusses how the availability and accessibility of digital devices determine if ICT use in schoolrooms will have a lasting effect on performance.

Availability and accessibility of digital devices determine if ICT use in schoolrooms will have a lasting effect on performance. The unavailability of PCs upset the school's ability to teach Mathematics (Caygill et al., 2010). The unavailability of PC software for teaching Mathematics was likewise shown as an impediment for around 66 per cent of learners (Caygill et al., 2010). However, there are no detected negative impacts of the utilisation of PCs for the school teaching of Mathematics on learners' performance in Singapore, Norway, and Australia (Eickelmann et al., 2017). Eickelmann, Gerick and Koop (2017) make a good point that the usability and quality of the new digital devices for teaching Mathematics should similarly be analysed with respect to ICT material proper for teaching. Considering teaching-learning of Mathematics, ICT devices that are mathematics-specific, for example, handheld devices utilising subject-specific programming or graphics display calculators (GDCs), remove the requirement for desktop

computers in the schoolroom, specifically in the event that they are not promptly accessible in the schoolroom (Eickelmann et al., 2017).

From an instructive perspective, it must be added that the recurrence of PC utilisation is an inadequate pointer of competence acquisition, as, from a Mathematics-related perspective, the acquisition of Mathematics abilities relies upon how PCs are utilised. The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. Again, this research will indicate, comparatively, that these digital devices as school-related resources are determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement. Next, the researcher discusses the ‘bring your device' policy in education and the use of technologies in formative assessment.

A policy called ‘bring your own device’ was established by educators and implemented technologies informative assessments. A policy in schools known as ‘bring your device’, as observed by Cooker, Crook and Ainsworth (2015) in their study of the incorporation of technological devices in IBDP, was one of the fundamental pointers of fruitful technological organisation and integration (Costa et al., 2020; Gain & Ancho, 2019; Stohlmann & Acquah, 2019). The ‘Bring your own device’ policy was found by Cooker, Crook and Ainsworth (2015) to be helpful in learner differentiation. Technology was

viewed as a supportive method of individual learners' learning needs, particularly in schools with well-coordinated 'bring your own device' policies, permitting learners to adjust and customise their own technological devices for learning (Cooker et al., 2015). In addition, educators can use ICT-based equipment for formative purposes, such as recording all IBDP Mathematics lessons and making them accessible on the school's virtual learning environment (VLE) for learners who might miss a lesson or need to review specific concepts (Cooker et al., 2015).

In different cases, educators can record utilising tablet PCs and upload it to the virtual learning environment to help learners review specific lessons or themes (Cooker et al., 2015). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. The current research comparatively investigates school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement. Next, the researcher discusses technology should be used as a vehicle and driven by pedagogy in Mathematics education.

Technology should be used as a vehicle and driven by pedagogy in Mathematics education. Cooker and friends (2015) observed that technology is turned into how inquiry learning is wholly driven into the Mathematics curriculum. Scholars (e.g. Cooker et al.,

2015; Gain & Ancho, 2019) suggest that technology ought to go about as a ‘transporter’ or ‘vehicle’ for the powerful teaching-learning interaction. Technology and its utilisation should consistently be driven by teaching methods (Cooker et al., 2015). Recent research (e.g. Costa et al., 2020; Lavicza & Prodromou, 2017) supports that videos positively affected learners and felt this high self-motivation in Mathematics lessons. Current research work (e.g. Costa et al., 2020; Stohlmann & Acquah, 2019) shows that videos promote enthusiasm in Mathematics lessons, assisting in concept understanding, making the content more exciting and lessening the absenteeism of learners.

Understanding learners today to improve learners' inspiration is vital for educators (Costa et al., 2020). The majority of the learners in our time belong to an age of the Digital World (Costa et al., 2020). Recent scholarly work (e.g. Gain & Ancho, 2019; Stohlmann & Acquah, 2019) indicated that integrating technology into Mathematics teaching and learning is a significant subject that requires further examination. Hence, the current research needs to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. The current study is anchored and informed by the first stage of Maslow’s hierarchy of needs. The next physiological needs to be explored concerning achievement in Mathematics under school-related resources are WhatsApp, YouTube, and Internet resources.

Whatsaap, YouTube, Internet Resources.

Social media platforms are WhatsApp, Twitter, Instagram, Pinterest, Linked In, and Facebook. Social media is an online application for individuals to give and take data, build relationships, and keep up their shared communications and participation (Abirin & Obra,

2019). Social communication locales allude to website-based service that permits people to create public/semi-public profiles inside a restricted framework, articulate lists of different uses which share connections, and view their lists of links and those made by others inside a framework (Abirin & Obra, 2019). The most mainstream person-to-person communication locales are WhatsApp, Twitter, Instagram, Pinterest, Linked In, and Facebook (Abirin & Obra, 2019). Social media upgrades the teaching-learning encounters of the learners and causes significant changes in their conduct in the schoolroom (Abirin & Obra, 2019).

The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. However, a question remains if social media as school-related resources determine Mathematics achievement among IBDP learners in South Africa and Singapore. That is what this research intends to explore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement. Next, the researcher discusses the availability, accessibility, and utilisation of social media resources.

Social media platforms are easy to use as they are easily accessible to all learners in a schoolroom. As indicated by Tham and Ahmed (2011) in Abirin and Obra (2019), however, there are negative discernments about the potential impacts of social communication sites on learners' educational achievement. On the other hand, Baran

(2009) in Abirin and Obra (2019) repudiated that a few investigations demonstrated that learners find it very proper for an educator to utilise Facebook (WhatsApp) and for educators and learners to associate social media. Learners likewise accepted that such devices could permit them to share information in conventional education settings (Abirin & Obra, 2019). Social media is a compelling way to secure better conversational abilities and raise the engagement of learners. Social media like Twitter, Facebook, and WhatsApp can improve the conversation between learners and educators (Abirin & Obra, 2019).

An educator of Mathematics can answer learners' questions using the WhatsApp platform, Twitter channel, or Facebook page, report forthcoming school events, post schoolwork, send text messages and updates, and share intriguing school-related information (Abirin & Obra, 2019). A fascinating part of social media is that it is not restricted to PCs (Mingle & Adams, 2015). Still, social media can be accessed through cell phones and mobile applications, making it entirely available or accessible and straightforward to utilise (Mingle & Adams, 2015). Ronan (2015) in Abirin and Obra (2019) asserted that as opposed to being viewed as a potential distractor, the utilisation of social media in the schoolroom is currently a driven engagement-learning vehicle.

The availability and upkeep of facility resources and learning resources were featured in Juta & Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. However, the question remains if the availability, accessibility, and utilisation of social media platforms determine Mathematics achievement among IBDP learners in South Africa and Singapore. That is

what this research intends to investigate. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement. Next, the researcher discusses the utilisation of ICT social media resources in education.

ICT teaching-learning resources have a negative effect if not properly monitored. Recent research confirms that ICT increases the probability of being distracted and performing multiple tasks, negatively affecting scholastic achievement (Giunchiglia et al., 2018b; Halpern et al., 2020). Halpern, Pina and Ortega-Gunckel (2020) investigated the effect of learning with YouTube, manually written notes, WhatsApp, and surfing through the Internet on the academic achievement of 12 to 18-year-old learners in Chile. The exploration left three significant outcomes. First, it was found that many learners simultaneously utilise various gadgets and platforms to learn. Second, the choice of utilising electronic resources relies upon their skills and enthusiasm to look at and assess data on the web. However, their capacity to control and regulate the utilisation of these ICT resources for learning purposes would be given. Third, the individuals who learn most often with handwritten notes get higher grades, while those who habitually learn with Whatsaap and YouTube get lower grades.

The lower performance from WhatsApp and YouTube users is on the grounds that learners perceive that they do not have higher capacities to deal with the material they get from the website nor the skills to self-manage their utilisation of gadgets when learning. Therefore, one of the fundamental difficulties learners face today is expanding

their ability to manage their work to various stimuli and figuring out how to choose online resources more effectively, accelerating the learning cycle (Claro et al., 2015). Abirin and Obra (2019) suggested that further research be conducted on utilising social-media-based Mathematics teaching as a lesson intercession versus impacts on learners' Mathematics performance. My contribution to knowledge is the comparative findings on investigating school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. Next, we discuss computer resources. The current study is anchored and informed by the first stage of Maslow's hierarchy of needs. The following physiological needs to be explored concerning achievement in Mathematics under school-related resources are computer resources.

Computer Resources.

Knowledge is power in education, raising the need for educators' professional development to improve learners' performance in Mathematics. For teaching to be successful, each educator ought to have the knowledge and excellent command of technology, pedagogy, concepts, high-tech pedagogy, high-tech content, pedagogic content, and high-tech pedagogic content (Joshi, 2017). Furthermore, the expertise and experience of educators, pre-service training programme, behaviour and motivation of learners, perceived capabilities, assessment and curriculum requirement, the culture of institutions, institutional support, accessibility to school-related resources, pedagogic beliefs, pedagogic and high-tech knowledge, workshop and professional development of educators can also influence the correct utilisation of technology in Mathematics teaching practice (Joshi, 2017; Lavicza & Prodromou, 2017).

The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. We intend to investigate if high-tech knowledge impacts mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement. Next, the researcher discusses the use of digital technologies as a vehicle to transport knowledge in the schoolroom.

Digital technologies are used as a vehicle to transport knowledge in the schoolroom. While the digital technologies accessible in instructive settings quickly emerge in amount and quality, the teaching method driving the innovation must stay at the bleeding edge (Cooker, Crook & Ainsworth, 2015b). Digital technologies ought to act as a ‘transporter/carrier/vehicle’ for the strong teaching-learning interactions (Cooker et al., 2015b). Digital technologies create intellectual thoughts for educators (Joshi, 2017). They can shape learners' earlier understanding, capacities and abilities, connections to the material with Mathematics concepts, address common knowledge and present other advanced concepts (Joshi, 2017). ICT or Digital technologies include a broad scope of curios, from the tiny cell phone to the enormous interactive whiteboard (Clay, Fotou & Monaghan, 2017).

Technological devices have advanced into our regular day-to-day lives, yet these days, they are likewise usually utilised in schools (Korenova & Mathematics, 2016). PCs,

tablets and cell phones are presently crucial for the lives of this new age of learners, so it's just characteristic that they are utilised for instructive purposes, too (Korenova & Mathematics, 2016). However, it remains as to how digital technologies can comparatively determine Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement. Next, the researcher discusses how digital technologies facilitate and improve Mathematics activities in teaching-learning practices.

The digital technologies the educator picks rely upon instructive objectives which he needs to accomplish, methods of learning which he needs to utilise, and the degree of technological proficiency of learners just as of the educator himself, and obviously on the accessibility of these technological devices (Joshi, 2017; Korenova & Mathematics, 2016). Computerised devices are not just an academic mechanism for educational process organisation, but they fortify, particularly Mathematics activities, for example, experiments, visualising, application, and so on (Hegedus, Laborde, Brady, Dalton, Tabach, Siller, Trgalova & Moreno-Armella, 2017; Joshi, 2017).

Mathematics and technology, irrespective of all the potential benefits of utilising technology, should be utilised effectively and thoughtfully (Ann et al., 2018; Hegedus et al., 2017). On the off chance that technology is utilised simply as an unfortunate obligation, and learners do not need to reflect on solutions or processes they have utilised in Mathematics, the utilisation of technology will not bode well by any means (Hegedus

et al., 2017). However, the utilisation of computerised devices in the academic field provides many chances for Mathematics educational routines (Hegedus et al., 2017). Educators and future educators need to be mindful of planning a prosperous undertaking that integrates technology into the schoolroom discourses to provide normative technological arguments and conjectures (Hegedus et al., 2017). However, digital technology may accentuate some undertakings in Mathematics while making others less significant (Hegedus et al., 2017). Technology makes it simpler for learners to retain learned concepts and put them to use when solving given tasks (Joshi, 2017; Retnawati, Yogyakarta, Wijaya, Yogyakarta, Yunianto, & Laksmiwati, 2020).

The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. However, the researcher still wants to investigate whether digital technologies determine mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement. Next, the researcher discusses the results of the Khanya project conducted in South Africa.

The use in a particular manner and not the ownership of the PCs has an effect. Computer facilities provided for Matric Mathematics classes in South Africa for the Khanya project in the Western Cape have not improved Matric Mathematics grades (Smith & Hardman, 2014). The non-improvement could only demonstrate that this

intercession is not enough to have any effect in isolation (Smith & Hardman, 2014). Simply put, different components blocking the improvement in Mathematics results in South Africa might be too solid to even think about being overwhelmed by this activity alone (Smith & Hardman, 2014). In the event that and when these different obstructions are defeated adequately, at that point, it is conceivable that the Khanya PCs may demonstrate their capacity to affect Mathematics results in a positive way (Smith & Hardman, 2014). The use in a particular manner and not the ownership of the PCs has an effect (Smith & Hardman, 2014). Further examination may explicitly address what kinds of PC applications pedagogically give the most significant and valuable tools/instruments for Mathematics teaching and learning (Lavicza & Prodromou, 2017).

PCs, unaided, could not affect Mathematics achievement. The way PCs are utilised essentially to see how they can affect achievement (Smith & Hardman, 2014; Yamaguchi, Sukhbaatar, Takada & Dayan-Ochir, 2014). Three problems were hindering the proper application of digital technologies: organising school time, organising school space, and preparing learners for examinations and tests (Cooker et al., 2015b). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. Therefore, this research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. The current study is anchored and informed by the first stage of Maslow’s hierarchy of needs. The following physiological needs to be

explored concerning achievement in Mathematics under school-related resources are calculator resources.

Calculator Resources.

Graphic Display Calculators enhance performance in Mathematics education. Throughout the century, digital technology has been demonstrated to be one of the significant apparatuses for progression in schooling (Arumugam, Talib, Wahidah, Hakim & Wiarsih, 2019). A model for the improvement of technology in schooling can be found in the use of the Graphic Display Calculator (GDC) (see *Figure 2*) (Arumugam et al., 2019).

A B C

Figure 2 (A) Texas Instrument 83 plus (TI83 plus), (B) Texas Instrument 84 plus (TI84 plus) and (C) Casio Graphic Display Calculators (GDCs)

Notes*:* (A) Texas Instrument 83 plus (TI83 plus), (B) Texas Instrument 84 plus (TI84 plus) and (C) Casio Graphic Display Calculators (GDCs) (Arumugam et al., 2019, p. 27).

Learners utilising GDC in learning Mathematics indicated enhancement in performance in Mathematics (Ann, Parrot & Leong, 2018; Arumugam et al., 2019; Balantes & Tonga, 2020; Chen & Lai, 2015; Kandemir & Demirbağ, 2019). Methods with flexibility in problem-solving and more profound gratitude were developed amongst learners who use GDC contrasted with the individuals who do not utilise GDC in their schooling (Ann, Parrot & Leong, 2018; Arumugam et al., 2019). Technology, with regard to Mathematics, for the most part, alludes to PCs, cell phones (smartphones) or tablets (Konya & Kovacs, 2019). In numerous nations, calculators viewed as conventional innovative gadgets are broadly utilised in compulsory Mathematics education (in the schoolroom just as in test circumstances and examinations) (Konya & Kovacs, 2019).

The majority of the advanced countries are implementing GDC and positive performance is noted (Ann et al., 2018; Arumugam et al., 2019; Chen & Lai, 2015; Kandemir & Demirbag, 2019). Researchers observe that the method of utilisation of calculators is improving (Konya & Kovacs, 2019). While it was utilised to help in essential counts, it has an expanding function in developing information and knowledge (Ann et al., 2018; Kandemir & Demirbag, 2019; Konya & Kovacs, 2019). Calculators enhance discovery-based learning by observing numerous cases (Balantes & Tonga, 2020; Konya & Kovacs, 2019). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management.

This research investigated if the calculator resource was a determinant of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement. Next, we discuss that calculator utilisation in Mathematics learning helps learners make problem-solving explorations, verifications, calculations, and representations. Calculator utilisation in Mathematics learning helps learners make problem-solving explorations, verifications, calculations, and representations.

Recent research indicates that methodical trials utilising the Spreadsheet-mode of the calculators assist with developing computational just as mathematical reasoning (Ann et al., 2018; Balantes & Tonga, 2020; Kandemir & Demirbag, 2019; Konya & Kovacs, 2019). However, the calculator's memory limitation may impede the exploration (Konya & Kovacs, 2019). Another perception that can be classified as a detriment of the calculator is that occasionally, it appears simpler to press the functions rapidly instead of discerning which numbers merit looking at (Konya & Kovacs, 2019). The utilisation of technological digital devices in Mathematics learning needs to address consideration regarding the reasonable costs, accessibility with ease, and operation of the technology gadgets (Chen & Lai, 2015; Retnawati et al., 2020). Calculators are identified as digital technological gadgets that meet this necessity (Retnawati et al., 2020). Calculators can be called mini-computers and can be utilised for different purposes in learning Mathematics (Retnawati et al., 2020).

The calculator utilisation in Mathematics learning helps learners make problem-solving explorations, verifications, calculations, and representations (Ann et al., 2018; Joshi, 2017; Kandemir & Demirbag, 2019; Retnawati et al., 2020). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to comparatively investigate if calculators, a school-related resource, are a determinant of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement. Next, the researcher discusses that the utilisation of technology in learning can encourage learners to learn.

The utilisation of technology in learning can encourage learners to learn. A series of research work shows that learners are guided to discern Mathematics concepts through explorations, to have longer retention of concepts in learners' minds to be utilised in critical thinking and problem-solving (Ann et al., 2018; Balantes & Tonga, 2020; Joshi, 2017; Kandemir & Demirbag, 2019; Retnawati et al., 2020). One methodology that can be utilised to assist learners in learning Mathematics is to incorporate the utilisation of calculators in the teaching of Mathematics (Retnawati et al., 2020). Many scholars (e.g. Ann et al., 2018; Joshi, 2017; Kandemir & Demirbağ, 2019; Retnawati et al., 2020) support that the learning quality of Mathematics could be facilitated by the use of technology on the grounds that the utilisation of technology in learning can encourage

learners to learn. Furthermore, technology has improved the interest of learners in Mathematics learning and made learning Mathematics fun (Ann et al., 2018; Balantes & Tonga, 2020; Kandemir & Demirbag, 2019; Retnawati et al., 2020).

Additionally, technological devices make it simpler for educators to teach Mathematics and assess learners (Ann et al., 2018; Joshi, 2017; Kandemir & Demirbag, 2019; Retnawati et al., 2020). For example, different technological items, calculators, the internet, software, and computers can be utilised by educators to facilitate the learning process in Mathematics (Ann et al., 2018; Joshi, 2017; Retnawati et al., 2020). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to comparatively investigate if these resources are determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement. Next, the researcher discusses that calculators can enhance the inductive intuition process if educators know how to utilise them.

Calculators can enhance the inductive intuition process if educators know how to utilise them. As one of the innovation items, calculators are inexpensive in a relative sense (Retnawati et al., 2020). A calculator can be used without any supportive software or accessibility to the internet (Retnawati et al., 2020). Despite the fact that calculators have numerous keys that can be used, not all educators in a Mathematics schoolroom have

utilised calculators in Mathematics learning (Retnawati et al., 2020). Not all educators understand the significance of utilising technology in the schoolroom in Mathematics learning (Kandemir & Demirbag, 2019; Retnawati et al., 2020). Individuals claim that calculators make learners languid to compute and think (Retnawati et al., 2020). Not all educators have adequate aptitudes to utilise calculators (Retnawati et al., 2020). Kónya and Kovács (2019) contend that the utilisation of calculators can enhance the inductive intuition process in the period of specific case observations and conjecture testing.

The manner in which learners utilise the calculator impacts their thinking processes (Ann et al., 2018; Balantes & Tonga, 2020; Kandemir & Demirbag, 2019; Konya & Kovacs, 2019). Moreover, the utilisation of calculators requires new learners' and educators' attitudes (Konya & Kovacs, 2019). Still, this intends to comparatively investigate if these resources are determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement. Next, the researcher discusses that a calculator is a valuable tool in Mathematics problem-solving, examinations, and other Mathematics learning areas.

A calculator is a valuable tool in Mathematics problem-solving, examinations, and other Mathematics learning areas. A calculator has a significant job in process-oriented exercises (Konya & Kovacs, 2019). In process-oriented activities, the calculations assist learners with finding patterns and test assumptions, thus permitting them to focus on the process itself (Konya & Kovacs, 2019). Utilising calculators in problem-solving most often

results in selecting appropriate approaches to an answer (Konya & Kovacs, 2019). The utilisation of GDC in instructing learning and public examinations of additional/further Mathematics was likewise allowed in Singapore in 2001 (Arumugam et al., 2019). In 1998, countries like Singapore, England, Japan, Australia, and the United States of America made it obligatory for schools to utilise GDCs (Arumugam et al., 2019).

The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. Hence, this research needs to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. Next, we discuss instructional material as a determinant of achievement in education. The current study is anchored and informed by the first stage of Maslow's hierarchy of needs. The following physiological needs to be explored concerning achievement in Mathematics under school-related resources are instructional material (e.g. textbook) resources.

Instructional Material (e.g., Textbook) Resources

Educational resources can be human or material. Teaching resources, otherwise called teaching aids, are resources and facilities which the educator utilises throughout the instruction process to show and clarify skills, concepts, procedures, strategies, abilities, and so on (Eraikhuemen & Omoregbe, 2017; Mueni & Githinji, 2019). There are two types of educational resources, namely human and material resources, organised for teaching-learning purposes (Mnuabueze, 2016). They are grouped into resources that might be physical (building structures, space and so forth), human (scholarly and non-

scholastic personnel), material (all equipment or teaching-learning aids and so on), and finances alongside programmes accessible in schools (Mnuabueze, 2016). They are crucial for the help and enhancement of instruction at all levels. Human resources incorporate academic personnel, non-academic personnel, and learners, and they are viewed as the most imperative resources in academic settings (Mnuabueze, 2016).

Material resources are viewed as teaching materials which incorporate school structures such as schoolrooms, labs, corridors, and libraries. Instructional aids and gadgets, for example, slides, projectors, audio-visual materials, magnetic tapes, textbooks, PCs, etc., and finances, are equipped to achieve the instructional objectives and goals (Mnuabueze, 2016). Academic material resources are delivered to optimise employees' and learners' efficiency in the teaching-learning practice (Mnuabueze, 2016). It can be briefly stated that material resources allude to those existing facilities used by educators during the time spent performing or actualising academic programmes and policies (Mnuabueze, 2016). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

Successful teaching-learning of Mathematics relies on the effective utilisation of teaching resources. Numerous research works in education (e.g. Adebule & Ayoola, 2016; Eraikhuemen & Omoregbe, 2017; Mueni & Githinji, 2019; Prado et al., 2020; Putri, Hasratuddin & Syahputra, 2019) found that the utilisation of teaching resources in the teaching-learning of Mathematics make Mathematics comprehension simpler, fascinating, concrete, pleasant and challenging. Research proof that the utilisation of teaching resources in the teaching of Mathematics improves learners' school performance in Mathematics (Adebule & Ayoola, 2016; Eraikhuemen & Omoregbe, 2017; Olayinka, 2016; Prado et al., 2020; Putri et al., 2019). On the other hand, if an educator is not correctly focused on utilising teaching materials for the development of Mathematics abilities, learning would be hindered, causing learners to passively learn Mathematics (Mueni & Githinji, 2019; Olayinka, 2016; Putri et al., 2019). Therefore, successful teaching-learning of Mathematics relies on effectively utilising teaching resources (Adebule & Ayoola, 2016; Eraikhuemen & Omoregbe, 2017; Mueni & Githinji, 2019; Prado et al., 2020). According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

Educators should be fully trained to be in a position to use teaching-learning resources correctly and successfully. Educators with a high, uplifting mentality toward the utilisation of teaching resources in teaching Mathematics are better inclined to utilise teaching resources (Eraikhuemen & Omoregbe, 2017). Non-trained educators in Mathematics teaching cannot successfully use teaching resources (Eraikhuemen &

Omoregbe, 2017; Olubunmi, 2020). To all Mathematics educators in pre-service training, accentuation ought to be put on exhibitions on the needs and practices of utilising teaching resources in teaching Mathematics (Eraikhuemen & Omoregbe, 2017; Olubunmi, 2020). A textbook is one of the school-related instructional resources (Caygill et al., 2010). The primary determinants of educational quality incorporate providing sufficient teaching staff members and textbooks, a favourable learning climate, and broad curricula executed through learner-centred collaborative approaches to teaching (Kapinga, 2017).

Instructional resource alludes to the non-human and human resources and structures utilised to calm, support, improve and advance teaching-learning undertakings (Mueni & Githinji, 2019; Odo & Ezeudu, 2018; Olayinka, 2016; Prado et al., 2020; Putri et al., 2019). Instructional resources are utilised in schooling lessons that incorporate dynamic assessments and learning (Odo & Ezeudu, 2018). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

Textbooks are a significant contribution to achievement in assessments. Excellent textbooks present more than Mathematics content, yet propose ways of interaction for

learners and educators with it and build meanings from it (Erbas, 2012). From this point of view, Singaporean textbooks reflect a basic yet incredible model for its clients by proposing an implied learning model, such as understanding, sharing, practising, solving problems, reflecting and summarising, and solving more complicated problems (Erbas, 2012; Yi & Lee, 2017). This implied model is designed by unequivocal underlying components inside the textbook (Yi & Lee, 2017). It is cultivated by simplicity and unambiguous concept organisation (Erbas, 2012; Yi & Lee, 2017). Lacking teaching-learning materials prompts educators to use different instructional approaches, leading to dormant learners (Mueni & Githinji, 2019).

Textbooks for Mathematics serve the learning of learners in multiple ways. They help them as learners read clarifications from their textbooks. The learner independently takes a shot at activities to fortify learning, as the learner takes care of tasks given for assignments/homework from the textbook (Erbas, 2012; Mueni & Githinji, 2019). In addition, a textbook serves as a resource for educators to return to and revive the Mathematics concepts they will be teaching, and a textbook suggests techniques to clarify and plan schoolroom exercises for educators (Erbas, 2012; Mueni & Githinji, 2019). A well-written textbook is proposed to reflect unequivocal strategic structures to encourage these different capacities for learners and educators (Erbas, 2012; Mueni & Githinji, 2019).

The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to

investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

Sufficient teaching-learning resources and professional development of educators have a positive effect on Mathematics education. In-service professional development training of Mathematics educators on the teaching of Mathematics, where they can observe shows of utilising various resources to teach multiple concepts in Mathematical, will improve their approach to the utilisation of teaching resources in Mathematics education (Eraikhuemen & Omoregbe, 2017; Olubunmi, 2020). Research has demonstrated that in African nations, the utilisation of Mathematics teaching materials has been grasped (Mueni & Githinji, 2019). However, insufficient instructional materials result in an educator-centred teaching approach, contributing to low-value education (Mueni & Githinji, 2019).

Research shows that sufficient teaching materials ought to be supplied by the Ministry of Education and school bodies (Adebule & Ayoola, 2016; Bassey & Okoro, 2019; Olayinka, 2016; Olubunmi, 2020). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the

framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

Educators and principals of schools play an essential role in teaching-learning practice. Principals of schools ought to provide educators, particularly inexperienced and untrained educators, opportunities to access teaching materials to enhance their teaching-learning practice (Adebule & Ayoola, 2016; Bassey & Okoro, 2019; Olayinka, 2016; Olubunmi, 2020). Principals of schools ought to likewise empower spontaneous improvisation of teaching materials by learners, educators, the schools' guardians/parents and the Ministry of Education to improve teaching-learning in schools and advance scholarly norms (Olayinka, 2016). Principals of schools and heads of departments should monitor educators routinely to guarantee the successive utilisation of teaching materials that could improve educators' competency (Bassey & Okoro, 2019).

Educators are urged to build up their teaching materials and use different teaching aids to improve the learning of learners (Olayinka, 2016; Prado et al., 2020). However, fundamental materials, for example, whiteboards, textbooks, and vital tools like PCs, data projectors, TV and videos, are not promptly accessible in numerous schools (Olayinka, 2016). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. The current study is anchored and

informed by the first stage of Maslow's hierarchy of needs. The following physiological needs to be explored in relation to achievement in Mathematics under school-related resources are support staff resources.

Support Staff Resources

Human resources are essential and valuable teaching-learning resources in the academic field. According to Barnett, Avila and Aklog (2017), a successful school provides staff resources to learners (clinicians, psychologists, social workers, and career guidance specialists) to help learners tackle complex subjects like that needed in the IBDP. Human resources are workers, labourers and administrators working for an organisation, community, or company (Aja-Okorie, 2017). Human resources are contract-employed people who work full-time or part-time, regardless of the type of job and have their perceived rights and obligations in an institution (Aja-Okorie, 2017). Human resources are responsible groups in an academic framework to actualise instructive objectives (Aja-Okorie, 2017). They actualise instructive policies (Aja-Okorie, 2017).

It can be expressed that teaching staff alludes to a proficient team straightforwardly engaged with educating learners (Aja-Okorie, 2017). However, the availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. Therefore, this research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and

utilised, learners will participate, engage, and collaborate to attain plausible school achievement.

The academic and non-academic staff work toward achieving the goal of attaining a good learner performance. Academic and non-academic staff are the significant categories of personnel in a school (Aja-Okorie, 2017). The academic staff (educators) alluded to the individuals who offer teaching-learning for learners (Aja-Okorie, 2017; Okigbo & Sunday, 2020). Therefore, it can be expressed that academic staff refers to a qualified workforce straightforwardly engaged with teaching learners (Aja-Okorie, 2017). The principal and trained educators who might be set in an authoritative framework in the school setting are also academic staff members (Aja-Okorie, 2017; Ansley, Blinder, Demere, Varjas, Benson & Ogletree, 2019). The principal usually is an educator who is a secondary school leader, and an entire school community leader (Okigbo & Sunday, 2020).

The principal is liable for dealing with significant administrative errands and directing all the school personnel, such as learners, educators, and support staff (Okigbo & Sunday, 2020). Nevertheless, the other non-academic workforce which assists educators in offering learners instructions is educators' assistants (Aja-Okorie, 2017). Non-academic staff are the individuals who expedite school programmes, supervise school accomplishment progress, convey multitudinous non-scholastic learning chances, and enable the academic workforce's work (Aja-Okorie, 2017; Ansley et al., 2019). In addition, they incorporate transport personnel, food administration workers, overseers,

librarians, career guidance counsellors, and administration staff (Aja-Okorie, 2017; Hines, Moore III, Mayes, Harris, Vega, Robinson & Jackson, 2017).

Both academic and non-academic staff are imperative to educational advancement (Aja-Okorie, 2017; Ansley et al., 2019; Okigbo & Sunday, 2020). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

The school personnel improves the scholastic participation, performance, and interest of the learners' education. The IBDP provides staff resources to learners (for example, psychologists, social workers, and guidance counsellors) to handle assignments in IBDP that are more challenging (Barnett et al., 2017; Hines et al., 2017). Education authorities ought to ensure accessibility to both material and human resources before schools are approved to operate (Okori & Jerry, 2017). School principals should provide staff and learners with a magnificent learning climate by allocating service specialists to keep the school environment tidy (Ansley et al., 2019; Gain & Ancho, 2019). Likewise, the financial plan should incorporate school gatekeepers to protect the school premises (Gain & Ancho, 2019).

School human resources are viewed as employees' capacities, aptitudes, abilities, and knowledge conceivably valuable to learning learners and society development (Ada & Msughter, 2019; Mnuabueze, 2016). The school personnel improves the scholastic participation of the learners through knowledge construction (Mnuabueze, 2016). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

The school's academic quality relies straightforwardly upon the educators' capacity, responsibility, inspiration, and a significant number of non-academic staff. School human resource improvement is the way toward getting and expanding the number of individuals who have the experiences, knowledge, and skills that are important for the financial advancement of the school (Ada & Msughter, 2019; Mnuabueze, 2016). It assists with expanding individuals' knowledge, capacities, thoughts and abilities (Ada & Msughter, 2019; Mnuabueze, 2016). It is continually connected with the interest in individuals and their improvement as creative and beneficial assets (Mnuabueze, 2016). It includes the expenditures on developments in education, personnel training and the

advancement of mentalities toward profitable practices in schooling (Ada & Msughter, 2019; Mnuabueze, 2016; Okigbo & Sunday, 2020).

Ensure that staff payment and remittances are as at when due and the provisions of different motivators (Okigbo & Sunday, 2020). It will raise the degree of productivity and hard work of the staff in the school (Ada & Msughter, 2019; Okigbo & Sunday, 2020). The school's academic quality relies straightforwardly upon the educators' capacity, responsibility, and inspiration, along with a significant number of non-academic staff serving and supporting at various jobs (Ada & Msughter, 2019). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. The current study is anchored and informed by the first stage of Maslow's hierarchy of needs. The following physiological needs to be explored in relation to achievement in Mathematics under school-related resources are educator resources.

Educator Resources

The educator, not the curriculum, makes the teaching-learning practice more effective. Lee, Walker and Bryant (2018) Investigated practices in leadership related to International Baccalaureate (IB) learner achievement. Educators see principals as robust leaders when they are viewed as successful and effective in designating school-related resources to help educators and learners in their teaching and learning. Pendergast, Dole and Rentoule (2014) analysed the discussion of learner experiences in an IBMYP and

IBDP Mathematics lesson in an independent school. Research reveals that each educator's chosen teaching methods are a significant contributing factor and determinant of learner involvement in schoolroom discussion. Therefore, the educator, not the curriculum, decides a learner's lesson experience, proposing that teaching method workshops be organised for specific educators for an effective change.

The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

The educator and his teaching method is a critical factor in deciding the performance of the learner. Pendergast, Dole and Rentoule (2014) analysed the discussion of learner experiences in an IBMYP and IBDP Mathematics lesson in an independent school. They found that factors that may affect learner achievement to a certain degree are capabilities, qualifications, and a number of educators in an institution, any discriminatory admission policies and funding sources, among others (Tan & Bibby, 2012b; Zilanawala et al., 2018). Learners in IBDP programmes report that their educators and advisors are both demanding and encouraging at the same time (Aldana & Mayer, 2017). IBDP learners value their educators' higher personal and academic expectations

(Aldana & Mayer, 2017). IBDP educators appear to be eager to invest energy outside of the school day to give additional assistance to their learners (Aldana & Mayer, 2017).

IBDP educators assist learners in defeating individual deterrents by telling their own experiences and re-directing learners' attention from the current conditions to a superior or better future (Aldana & Mayer, 2017). IBDP learners likewise shared that their educators inspire them (Aldana & Mayer, 2017). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners will participate, engage, and collaborate to attain plausible school achievement.

The system of education's quality relies upon the quality of educators. Successful learning is a multi-faceted undertaking that needs educators' and learners' energy in equal amounts (Holman et al., 2015). The relationship between educator efforts and learner results will eventually reveal the effectiveness of the school in preparing learners to flourish educationally, first to acquire their secondary school diplomas, and lastly, their college degrees (Holman et al., 2015; Zilanawala et al., 2018). It is not just the joint endeavours and commitment of the educator and learner that direct this excursion to progress, but the transparent communication between the inspirations, philosophies and

activities of the educator and learner, as two school principal players (Holman et al., 2015).

Educators who are already in the teaching profession should be re-trained through on-job training, for example, workshops, seminars and conferences to bring their knowledge up-to-date (Ada & Msughter, 2019; Bassey & Okoro, 2019; Eraikhuemen & Omoregbe, 2017; Okigbo & Sunday, 2020; Oviawe & Uddin, 2020; Zilanawala et al., 2018). The system of education's quality relies upon the quality of educators and the school (Ada & Msughter, 2019; Letsoalo et al., 2019; Nurcahyono & Novarina, 2016). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

Factors of educators like level of education, experience in the teaching profession, and interest in teaching affect learner achievement. Recent scholarly work (e.g. Ada & Msughter, 2019; Adegoke & Mefun, 2016; Bassey & Okoro, 2019; Zilanawala et al., 2018) indicate that accessibility to extraordinarily effective and qualified educators is a problem of great worry on the grounds that educators have a significant effect on learner performance. On the other hand, there is a positive relationship between educators with

Mathematics and full certification (Ada & Msughter, 2019; Eraikhuemen & Omoregbe, 2017; Okigbo & Sunday, 2020; Zilanawala et al., 2018). Among the more vigorous pointers of educator quality, at least three years of educator experience have appeared to relate emphatically with learner achievement (Letsoalo et al., 2019; Zilanawala et al., 2018). However, in high and low-poverty schools, experienced educators are not distributed equally (Adegoke & Mefun, 2016; Zilanawala et al., 2018).

Educators who are experienced are attracted to elite schools with top learner performance and few minority and poor learners (Adegoke & Mefun, 2016; Zilanawala et al., 2018). Additional proof is that high educator turnover represses low-achieving schools from improving learner performance (Adegoke & Mefun, 2016; Zilanawala et al., 2018). Amongst the most noticeable drives behind the disappointment of educators lately have been stresses related to assessment-based responsibility, despondency with managerial assistance, and dissatisfaction with the teaching profession (Carver-Thomas & Darling-Hammond, 2017). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

Educators exit the teaching profession for greener pastures in other occupations. Educators are viewed as the principal teaching material inside the schoolroom (Gain & Ancho, 2019; Hendrawijaya, 2020). Zeroing in on their expert development and advancement is broadly observed as a fundamental method for teaching-learning improvement (Bassey & Okoro, 2019; Gain & Ancho, 2019; Okigbo & Sunday, 2020). Learner engagement and achievement in Mathematics are decreasing, and trained educators need to improve teaching and learning (Timms et al., 2018). The Mathematics educational programme is uneven and disjointed, instigating a lack of interest among learners (Timms et al., 2018). In the absence of qualified educators, a few educators are forced to teach a somewhat unconnected subject from their field of specialisation (Adegoke & Mefun, 2016).

After a couple of years in education, a few educators moved to better-paying professions as greener pastures (Ada & Msughter, 2019; Adegoke & Mefun, 2016; Okigbo & Sunday, 2020). In certain nations, educator deficiencies may occur partly because of deprived employment conditions (Fah & Chandrasegaran, 2016). Educators who exit the calling after only a few years are bound to exist due to deprived employment conditions in light of low salaries (Ada & Msughter, 2019; Fah & Chandrasegaran, 2016; Okigbo & Sunday, 2020). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the

framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

A good Mathematics educator, according to learners' perception, is somebody who clarifies Mathematics well. Due to continuous conflicts in schools, educators may choose to begin anywhere they like and make learning hard for learners (Aja-Okorie, 2017). Excellent health condition is seen as another source of bliss for educators (Ada & Msughter, 2019). It is a bliss for educators because they are fit to coordinate the undertakings of their lives whenever they are liberated from diseases (Ada & Msughter, 2019). A good Mathematics educator, according to learners' perception, is somebody who clarifies Mathematics well yet additionally considers the positive educator-learner relationship (Yesildere-Imre, 2017).

A positive learner-educator relationship has fairness, respect, acceptance, support, caring, warmth, emotional closeness, and low degrees of dependency and conflict (Yesildere-Imre, 2017). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. The current study is anchored and informed by the first stage of Maslow's hierarchy of needs, whereby the next physiological needs to be explored in relation to achievement in Mathematics under school-related resources are school buildings and grounds resources.

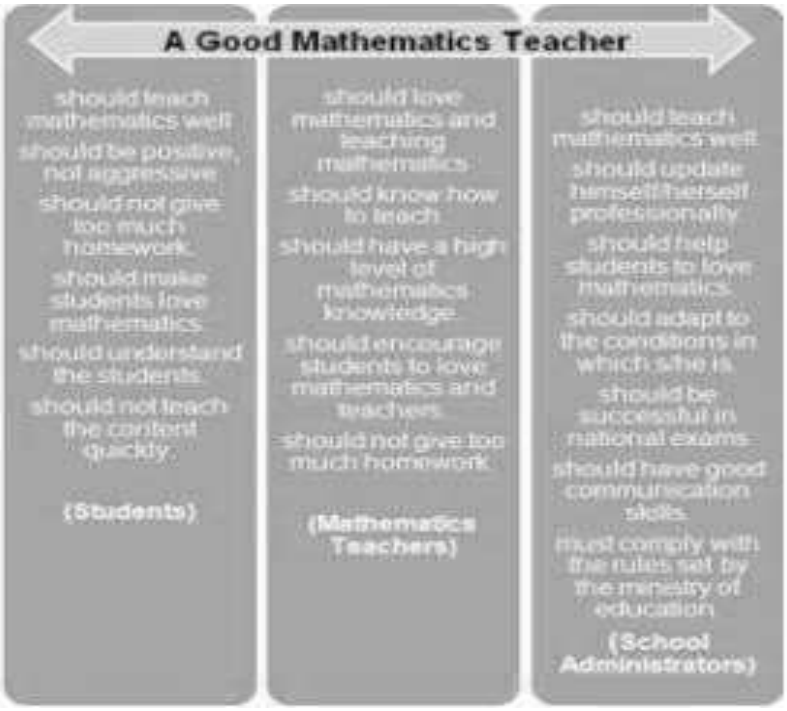

Figure 3 Characteristics of a good Mathematics educator according to Learners, Educators, and Administrators
Notes: Characteristics of a good Mathematics educator according to Learners, Educators, and Administrators (Yesildere-Imre, 2017, p. 41)

Budget for Supplies (e.g., paper, pencil) Resources

Educational finance is all exercises outfitted towards sourcing, distributing, and overseeing state-funded school incomes in the construction of academic services to accomplish instructive goals (Mnuabueze, 2016). Finance for education can be additionally categorised into two specific: learner finances and school finances (Mnuabueze, 2016). School account identifies with the expense of overhauling the different contributions to the instructive framework, like the physical and human assets (Mnuabueze, 2016). Then again, learner finances can be characterised as any help or support through cash provisions or resource materials, such as materials, stationery,

equipment, and books, offered to needy learners to pay for their education costs (Mnuabueze, 2016).

Learner finances can be in exchange programmes, donations, foreign aid, graduate fellowships, bursaries, grants, loans, and scholarships (Mnuabueze, 2016). Wellsprings of financing schooling include income-generating events, tuition charges, endowment and donations funds, and government grants and subvention (Mnuabueze, 2016). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

Schools follow an indistinguishable calculated strategy to designate monetary resources yearly (Gain & Ancho, 2019). As general administrations, seminars and training, materials and supplies, maintenance, and repair costs increase, learner achievement likewise increases (Gain & Ancho, 2019). The positive association between monetary consumption and learner achievement is grounded in Mathematics (Gain & Ancho, 2019). Spending economic resources also influences learner achievement in various subject fields, not the whole achievement (Gain & Ancho, 2019; Mnuabueze, 2016). Teaching-learning expenses and learner achievement have a relationship that is

significant (Gain & Ancho, 2019; Mnuabueze, 2016). Supplies and material expenses and training and seminar expenses are two major finance expenses known to affect teaching (Gain & Ancho, 2019; Mnuabueze, 2016).

What affects learner achievement is spending and not the sum spent (Gain & Ancho, 2019). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

Even though cash is needed to help all parts of the school, the measure of money used might be insignificant to the manner in which it is spent to improve scholarly achievement (Gain & Ancho, 2019). Schools with many allotted resources used in schoolrooms have better academic achievement than schools that spend less on resources (Gain & Ancho, 2019). In addition, an effective and productive school spends more on expenses that will straightforwardly affect the teaching-learning practice, which incorporates the sum paid to educators and teaching materials (Gain & Ancho, 2019). Significant improvement in learner achievement is realised when a school invest in developing its educators (Gain & Ancho, 2019; Mnuabueze, 2016). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's

(2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. The current study is anchored and informed by the first stage of Maslow's hierarchy of needs. The following physiological needs to be explored concerning achievement in Mathematics under school-related resources are school buildings and grounds resources.

School Buildings and Grounds Resources

The learning surroundings or physical facilities directly affect learner performance (Gain & Ancho, 2019; Kapinga, 2017). For the most extraordinary learning experience to occur, the school surroundings and the schoolrooms must be in their best condition (Gain & Ancho, 2019). School principals should provide school staff and learners with a magnificent learning climate by allocating service specialists to keep the school environment tidy (Gain & Ancho, 2019). Likewise, the financial plan should incorporate school gatekeepers to protect the school premises (Gain & Ancho, 2019). Schoolroom spaces should be incorporated into school grounds plans to manage, maintain, and support (Porterfield, Diaz & Waltz, 2020). School structures, as designed environment, has negative or positive direct effects on academic undertakings (Kasım & Rengin, 2018; Mnuabueze, 2016).

Variables causing learners to learn uncomfortably in schoolroom consist of noise outside the schoolroom, absence of trees around the schoolroom, schoolroom desks, accessibility and state of seats, safety of roof conditions, the security of the wall, and

protection of schoolroom structures as well as poor floor (Kapinga, 2017; Widiastuti et al., 2020). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners will participate, engage, and collaborate to attain plausible school achievement.

Top-performing schools are those with the best facilities, playing grounds, laboratories, and libraries. Kapinga (2017) and Mnuabueze (2016) uncovered that learners develop more pleasure with education with the availability of utilitarian latrines and urinals, decent playing ground, blossoms planted at explicit areas in the premises of the school, and numerous other alluring teaching-learning facilities. The five sorts of public school facilities are open spaces, laboratories, support facilities, academic spaces, and administration spaces (Kapinga, 2017; Mnuabueze, 2016). As mentioned earlier, adequate provision and management of the facilities are essential (Ibrahim, Osman, Bachok & Mohamed, 2016; Kapinga, 2017). Therefore, top-performing schools have the best facilities, playing grounds, laboratories, and libraries (Kapinga, 2017; Mnuabueze, 2016).

Overcrowded schoolrooms meddle with learners' sitting locations and make learners’ writing very challenging (Kapinga, 2017). At the same time, educators find it

complicated to move from one learner to another to assist struggling learners or check learners' work during the lesson (Kapinga, 2017). The absence of school facility provisions leads to low achievement, which frequently hinders the school curriculum execution procedure (Suleiman et al., 2018). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. The current study is anchored and informed by the first stage of Maslow's hierarchy of needs. The next physiological needs to be explored in relation to achievement in Mathematics under school-related resources are heating/cooling and lighting system resources.

Heating/Cooling and Lighting System Resources

Learning limit and achievement rely on the state of being of the space learners are in, not only upon the individual factors, for example, inspiration, mental conditions and insight (Kasım & Rengin, 2018; Widiastuti et al., 2020). In terms of lighting and light, excellent visual solace/comfort must be given to provide total, precise, energetic and effortless learning, which is one of the components of the actual surroundings (Kasım & Rengin, 2018). The comfort of learning for learners can be achieved with a comfortable room temperature of 23ºC-28ºC, depending on the region of the world, clean schoolrooms, and great schoolroom lighting (Widiastuti et al., 2020).

The warming and cooling of the schoolroom is an interchange between sunshine entering the schoolroom, warming, air acclimatising and cooling structures existing operate-able windows, and the activities of the learners and the educators such as utilising heat creating hardware, solar screens, windows, opening doors, and so on (Bluyssen, Zhang, Kurvers, Overtoom, & Ortiz-Sanchez, 2018). It is consistently challenging to satisfy everyone if there are many people in a single schoolroom (Bluyssen et al., 2018). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

The school lighting influences the achievement of the learner. Besides home, learners spend most of their time at school (Bluyssen et al., 2018). Therefore, the conditions of the environment in a schoolroom might not be acceptable, for example, unsatisfactory warming or lighting, noise, and poor ventilation, and might affect the achievement, comfort and health of the learners (Bluyssen et al., 2018; Heebøll et al., 2018; Widiastuti et al., 2020). In addition, internal or external noise affects learners' achievement (Bluyssen, 2016; Bluyssen et al., 2018; Widiastuti et al., 2020). Therefore,

the school lighting influences the learner's achievement and energy utilisation (Al-Khatatbeh & Ma'bdeh, 2017; Kasım & Rengin, 2018; Widiastuti et al., 2020).

Warming-cooling and lighting are the most energy users in the school, and it is practically equivalent to the financial plan for books and different necessities (Al-Khatatbeh & Ma'bdeh, 2017; Kasım & Rengin, 2018). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

A lighting plan in a school ought to be in a manner to support learners and individuals from staff to complete their activities in a comfortable, delightful and safe way (Kasım & Rengin, 2018; Widiastuti et al., 2020). In addition, the potential adaptabilities and limitations must be considered (Kasım & Rengin, 2018). Numerous nations' appropriate guidelines and regulations have information about the necessary lighting conditions (Kasım & Rengin, 2018). Similarly, the guidelines contain information on internal equipment and surface materials (Kasım & Rengin, 2018). For example, a schoolroom with almost no normal ventilation causes warm distress, needs air-conditioning and produces odour problems (Montiel, Mayoral, Pedreno, Maiques, & Santos, 2020; Widiastuti et al., 2020). Regardless, tenants who work in an unprotected

area from draughts and rains become highly uncomfortable thermally (Montiel et al., 2020). In addition, an unprotected area can prompt medical issues (Montiel et al., 2020).

If the structure needs more indoor spaces, educators and learners regularly feel uneasiness (Montiel et al., 2020). This reality likewise restricts the pedagogy, display of project work, and demonstrations/exhibitions are limited and more costly in the event that they do happen (Montiel et al., 2020). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. The current study is anchored and informed by the first stage of Maslow's hierarchy of needs. The following physiological needs to be explored in relation to achievement in Mathematics under school-related resources are instructional space (e.g. schoolroom) resources.

Instructional Space (e.g., schoolrooms) Resources

The value/quality of instruction is affected when teaching methods are not completely lined up with actual learning spaces (van Merrienboer & Mckenney, 2017). This issue is identified with old-school structures that do not fit present-day teaching methods yet, in addition to spic and span school structures planned without giving a focal function to an educational vision shared by its clients (van Merrienboer & Mckenney, 2017). Frisby (2019) suggests tips to expedite learner contribution, creating a favourable actual space and subject structures, such as utilising roundabout seating arrangements and maintaining smaller class sizes. However, our objective has been to limit class size

as expected to consider more crucial social distancing during the COVID-19 pandemic (West, 2020).

Taking out superfluous furniture from the schoolrooms to create more spaces between learners' tables is imperative (Mnuabueze, 2016; West, 2020). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

Amendments to the structural learning space in schoolrooms and a learner-centred instructional method can emphatically impact learner conduct during the teaching-learning time (Kariippanon, Cliff, Lancaster, Okely & Parrish, 2019). The learner-centred approach permits learners to exploit openings made by the assortment of furniture and resources, such as group desks, working stations, and writeable dividers (Kariippanon et al., 2019). At that point, more prominent collaboration and interaction stream on from separating the entire class setting and making conditions that encourage group work (Kariippanon et al., 2019; Olanrewaju, 2019). Learners in flexible learning spaces spend significantly less energy/time in an entire class setting (see *Figure 4*) and additional time doing group work than in conventional schoolrooms (Kariippanon et al., 2019).

In learning spaces that are flexible (see *Figure 4*), learners spend more energy/time positively interacting and collaborating with their friends and take additional time to present their work back to the whole class (Kariippanon et al., 2019; Mnuabueze, 2016). In addition, learners in learning spaces that are flexible spend a more prominent extent of class time effectively engaging with the lesson (Kariippanon et al., 2019). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

Figure 4 A flexible learning space

A flexible learning space

Notes: A flexible learning space (Kariippanon et al., 2019, p. 4)

These flexible learning spaces have a variety of furniture alternatives in a generally open space that can be designed in different arrangements to encourage a scope of teaching-learning encounters (Kariippanon et al., 2019; Mnuabueze, 2016). They remain distinct from old-style or conventional schoolrooms described by rows of tables and seats (see *Figure 5*) in front of an educator who utilises prevalently didactic teaching-learning methods (Kariippanon et al., 2019). These conventional conditions are currently considered insufficient to convey 21st-century skills to learners (Kariippanon et al., 2019).

There is a far-reaching acknowledgement that the teaching-learning scene in schools is quickly advancing (Kariippanon et al., 2019; Yi & Lee, 2017). Expecting educators to utilise creative/innovative methodologies and conform to the computerised age to guarantee twenty-first-century school learners remain engaged while meeting their needs in learning (Kariippanon et al., 2019; Yi & Lee, 2017). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

Figure 5 A conventional schoolroom

A conventional schoolroom

Notes: A conventional schoolroom (Kariippanon et al., 2019, p. 4).

Integrating virtual space into the teaching-learning environment requires extra adjustments to the buildings and the instructive method to take advantage of the affordability of innovation and technologies (Kariippanon et al., 2019). Teaching differentiated for customised learning is neither conceivable nor compelling in conventional schoolrooms and should go along with differentiated spaces (Kariippanon et al., 2019; Yi & Lee, 2017). Factors, for example, splendidly hued furniture, normal light from outside, quality of the air, and interior plants were all reportedly to improve learners' feeling of passionate prosperity (for example, glad, motivated, and feeling calm) in the schoolroom and brought about an enhanced attitude toward learning (Kariippanon et al., 2019). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help

or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners will participate, engage, and collaborate to attain plausible school achievement.

Learners report that they are often distracted in flexible space schoolrooms (Kariippanon et al., 2019). The distraction directly results from the expanded attention on collaboration (Kariippanon et al., 2019). Learners are urged to deliberate with friends about what they learn in class without fundamentally having the self-restraint to remain on the topic (Kariippanon et al., 2019). Getting distracted was additionally encouraged by the format and furniture arrangement (Kariippanon et al., 2019). With the liberty to work in various places, such as a detached corner or in the passage, learners ended up being noticed less by the educator and all the more quickly flustered by their friends (Kariippanon et al., 2019). Learning space that is flexible regularly can hold a more significant number of learners than a conventional schoolroom, which is a plan that is open and does not have dividers to give spaces that are isolated (Kariippanon et al., 2019).

It is accepted that these challenges of flexible learning spaces could be overwhelmed with teaching practices that are effective as learners turn out to be more familiar/accustomed to learning in flexible spaces (Kariippanon et al., 2019). It is recognised that educators and learners need help during the change stage/phase

(Kariippanon et al., 2019). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. The current study is anchored and informed by the first stage of Maslow's hierarchy of needs. The following physiological needs to be explored concerning achievement in Mathematics under school-related resources are relevant library material resources.

Relevant Library Material Resources

Library schoolrooms should have a whiteboard, furniture so learners' collaboration and versatility are augmented, calm fans or air conditioners, height customisable table for accessibility, lockable stockpiling bureau, work of art, school photographs, projects of learners pinned on the wall, school materials that learners would discover valuable, hand-outs, a shelf with books, a new paint plot that incorporates relaxing or energising colours except for white, a door with a bit of window with the end goal for learners to have the option to see all through the space and to potentially increase regular light in the room, a projection screen and a data projector immovable or mobile in the spaces, folding and adaptable furniture for various schoolroom settings, and a lightweight laptops' cart such as Chromebooks for learners to utilise rather than immovable desktop computers, mounting skylights or windows if conceivable to boost natural lighting in the space, electrical sources in different regions of the room for accessibility to every learner from their table, mounting customisable (dim-bright) lighting in other territories of the room, at

least 25 square feet assigned per learner to take into account for collaboration, accessibility, flexibility, comfort, and have Wi-Fi availability and accessibility (Porterfield et al., 2020). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners will participate, engage, and collaborate to attain plausible school achievement.

Academic libraries should have deliberately planned informal learning spaces where learners can work together with peers, study alone, and even participate in new techniques for knowledge construction in spaces (Porterfield et al., 2020). Academic libraries incorporate proper learning spaces, or schoolrooms, where subject-integrated knowledge education, among different kinds of teaching-learning, occurs (Porterfield et al., 2020). The presence of the school library as a learning resource centre is still not used ideally by the community of the school (Sidik, 2020). As a teaching-learning resource, the school library is not just the finishing point of the school; learners can use it as a learning resource (Sidik, 2020). The utilisation of libraries as a teaching-learning asset is likewise compelling towards learner learning achievement (Sidik, 2020).

The library staff ought to be professionally trained by means of on-the-job training programmes (Ternenge & Agipu, 2019). The availability and upkeep of facility resources

and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. The current study is anchored and informed by the first stage of Maslow's hierarchy of needs, whereby the next physiological needs to be explored in relation to achievement in Mathematics under school-related resources are audio-visual and video media resources.

Audio-visual and Video Media Resources

Teaching resource materials incorporate visual audio, television, computers, and chart materials (Okori & Jerry, 2017; Oviawe & Uddin, 2020). When these resource materials are not accessible/available or insufficient, the educator is relied upon to ad-lib (Okori & Jerry, 2017). Video-recording media is a powerful and valuable learning medium utilised in the academic field (Oktovianus, 2019). A video recording is a progression/series of moving pictures that join sound/audio and visual (Oktovianus, 2019). The visual component is moving images that visualisation can perceive (Oktovianus, 2019). In contrast, the audio feature is the sound that permits learners to have the option to obtain learning communications through the sense of hearing (Oktovianus, 2019).

The audio-visual teaching-learning approach significantly impacts learners' academic performance and interest in Mathematics (Costa et al., 2020; Olagbaju & Popoola, 2020; Oviawe & Uddin, 2020). Therefore, it is presumed that the audio-visual teaching-learning methodology is a superior teaching-learning approach to the educator-

centred methodology for schoolroom teaching (Oviawe & Uddin, 2020). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners will participate, engage, and collaborate to attain plausible school achievement.

The use of audio-visual resources improves learners' performance. Oviawe and Uddin (2020) studied the impact of audio-visual material as a teaching method for enhancing learners' academic performance in geometry. A lesson that is enhanced with audio-visual resources extraordinarily improves the learning results of learners in school subjects (Costa et al., 2020; Olagbaju & Popoola, 2020; Oviawe & Uddin, 2020; Stohlmann & Acquah, 2019). The use of audio-visual resources improves learners' performance (Olagbaju & Popoola, 2020; Oviawe & Uddin, 2020; Stohlmann & Acquah, 2019). The use of audio-visual material significantly affects the lessons in secondary schools (Costa et al., 2020; Oviawe & Uddin, 2020; Stohlmann & Acquah, 2019).

Senior secondary school learners trained with audio-visual supported lessons achieve better than those taught with conventional methods (Costa et al., 2020; Olagbaju & Popoola, 2020; Quarcoo-nelson, Buabeng & Osafor, 2012; Stohlmann & Acquah, 2019). The availability and upkeep of facility resources and learning resources were

featured in Juta and Van Wyk's (2020) study in South Africa as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

Video recordings and audio have been utilised in supporting teaching-learning for quite a while, yet new technology has come up. Although the expense of creating media materials has plummeted, it is currently feasible for different instructors to record their video recordings and audio, utilising the technologies accessible each day (Quevedo, Lijo´-Sa´nchez, & Garci´a-Cremades, 2017). Video recordings, therefore, are a famous device utilised in engaging learners and improving their learning experiences (Costa et al., 2020; Olagbaju & Popoola, 2020; Oviawe & Uddin, 2020; Quevedo et al., 2017; Stohlmann & Acquah, 2019). Subsequently, video recordings are a phenomenal method for demonstrating procedures, presenting and expanding concepts or increasing the comprehension of learning in progress (Costa et al., 2020; Olagbaju & Popoola, 2020; Quevedo et al., 2017; Stohlmann & Acquah, 2019).

Educators and guardians/parents can utilise specific video recordings to strengthen schoolroom theories by demonstrating ideal situations (Quevedo et al., 2017; Stohlmann & Acquah, 2019). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study in South Africa as elements

that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

The utilisation of video recordings as Mathematics learning media assumes a function incomprehension of the lessons, improving learners' performance, improving learners' knowledge, and improving learners' inspiration (Costa et al., 2020; Oktovianus, 2019; Olagbaju & Popoola, 2020; Oviawe & Uddin, 2020; Stohlmann & Acquah, 2019). Utilising video recordings in learning Mathematics positively affects Mathematics instruction (Costa et al., 2020; Oktovianus, 2019; Olagbaju & Popoola, 2020; Oviawe & Uddin, 2020; Stohlmann & Acquah, 2019). In the learning process, learning video recordings, as a learning mode, positively affects learners on psychomotor, affective, and cognitive (Costa et al., 2020; Oktovianus, 2019; Olagbaju & Popoola, 2020; Oviawe & Uddin, 2020). The psychomotor facet is hard to practice and should be possible repeatedly through individual learning utilising a learning video recording (Oktovianus, 2019). The effective facet, through video recording, affects learners' emotions and attitudes (Oktovianus, 2019; Oviawe & Uddin, 2020; Stohlmann & Acquah, 2019). The cognitive facet can reinforce and recall learners' comprehension of learning (Oktovianus, 2019; Oviawe & Uddin, 2020). The function of video recording as a learning vehicle raises

learners' interest in learning (Costa et al., 2020; Oktovianus, 2019; Olagbaju & Popoola, 2020; Oviawe & Uddin, 2020; Stohlmann & Acquah, 2019).

Learners become energised and more concentrated on the given material (Costa et al., 2020; Oktovianus, 2019; Olagbaju & Popoola, 2020; Oviawe & Uddin, 2020). The availability and upkeep of facility resources and learning resources were featured in Juta & Van Wyk's (2020) study as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners will participate, engage, and collaborate to attain plausible school achievement.

Audio-visual resource materials can contain numerous kinds of copyright material (Balakrishnan, 2009; Flynn, 2009). For instance, a solitary TV programme recorded on a videotape or a DVD can incorporate independently secured artistic, dramatic, fictional, and melodic works, sound chronicles and films (Flynn, 2009). Every recording, film and their fundamental works can have distinctive copyright proprietors (Balakrishnan, 2009; Flynn, 2009). In the event that one runs over audio-visual resource-material online, it is probably going to be secured by copyright (Balakrishnan, 2009). While a site, in general, is not ensured by copyright, distinct parts of it, such as sound chronicles, music, and video-recording files, will probably be secured (Balakrishnan, 2009; Flynn, 2009).

The case could be valid regardless of whether the material is old (Balakrishnan, 2009). For instance, copyright holders ensure Charlie Chaplin's motion pictures because

of the sensational works (Balakrishnan, 2009). So, one cannot openly utilise resource-material because it is accessible on the internet (Balakrishnan, 2009; Flynn, 2009). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

For the most part, audio-visual resource-materials viewed as schoolroom cooperatives incorporate TV academic programs, PowerPoint, academic DVDs, opaque projected materials, microforms, filmstrips, slides, and sound materials on MP3 and MP4 (Olagbaju & Popoola, 2020). In any case, there is a significant increment in the utilisation of web-based media devices by learners, for example, YouTube, 2go, Twitter, WhatsApp, Facebook, etc. (Olagbaju & Popoola, 2020; Raju, 2023). Audio-visually improved web-based social-media devices can become significant teaching-learning assets in presenting lessons in a straightforward, interactive, effective, simple, and intelligent way to learners (Olagbaju & Popoola, 2020). Learners invest loads of energy investigating web-based social-media applications, for example, WhatsApp, Twitter, Facebook, 2go, etc., contributing fundamentally to the number of clients of ICT assets (Olagbaju & Popoola, 2020). A flipped schoolroom application is a handy tool in the teaching-learning process (Costa et al., 2020).

The flipped schoolroom model depends on the possibility that conventional teaching-learning practice is modified as what is ordinarily done in the schoolroom is flipped or exchanged with what is typically done by the learners out of the schoolroom (Costa et al., 2020). In that case, learners are welcome to study publications, watch video recordings, and read materials that permit them to take in a schoolroom setting a more energetic discussion, reflection and breakdown of the subject being studied (Costa et al., 2020). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

A video recording permits learners to learn at their own speed and urges learners to participate in the teaching-learning practice effectively. It opens up real schoolroom time for more active, creative, and effective learning exercises. As a result, educators get extended chances to collaborate with and evaluate learners' learning, and learners assume control and accountability for their learning (Costa et al., 2020; Nouri, 2016; Stohlmann & Acquah, 2019). A few research work uncovered that flipped schoolroom is prominently recognised in advanced education (Costa et al., 2020). Flipped schoolrooms encourage the participation of learners in schoolrooms because academics inform and

rationalise the motivation behind the flipped schoolroom model to learners (Betihavas et al., 2016; Costa et al., 2020; Stohlmann & Acquah, 2019). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

As for simple videos, one ought to keep the video as basic as expected and avoid interruptions (Brame, 2016; Costa et al., 2020). It is essential to take out the material that does not add to the learning objectives, for instance, background noise, music and additional highlights that can distract attention (Costa et al., 2020). In light of valuable encounters, in an instructive video-recording, the presenter welcomes the learners first, furnishing them with a review of the impending theme and afterwards, the presenter ought to vanish, and, before the conclusion of the video-recording the presenter shows up to thank the audience for watching and finishing on a farewell note (Buchner, 2018; Costa et al., 2020). As for short videos, instructive video recording size is a significant variable to keep learners viewing until the end (Costa et al., 2020).

The ideal duration for video recordings is six minutes at most (Costa et al., 2020). However, the most engaging video recordings were found to be three minutes in length, which agrees with different scholars who found that two to five minutes of video length

were favoured (Buchner, 2018; Costa et al., 2020; Stevenson et al., 2014). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. The current study is anchored and informed by the first stage of Maslow's hierarchy of needs. The following part discusses the challenges of school-related resources.

Challenges of School-related Resources

Concerning challenges experienced by learners, it was discovered that these technology tools cause numerous pedagogical difficulties. For example, new schoolroom technology devices distract learners' responsiveness, driving learners to spend a large portion of their energy with them, making learners passive and utilise these technology devices for gaming (Celik et al., 2017a; Drossel et al., 2017; Varier et al., 2017). There are pedagogical challenges experienced by both educators and learners in technologically supported learning environments (Celik et al., 2017a). Educators say that they experience the ill effects of a weighty outstanding burden/workload, the need to cope with professional development courses, dealing with assessment nervousness for learners, consultation with colleagues is a challenge, and unable to keep up with the curriculum (Celik et al., 2017a; Drossel et al., 2017). Some educators gripe that they cannot visually connect with learners because of utilising these technologies in

schoolrooms (Celik et al., 2017a). Schoolroom management gets more problematic due to the technologies presented (Celik et al., 2017a).

Since learners utilise their tablets and educators centre around utilising technology in class, schoolroom management gets more challenging (Celik et al., 2017a). Educators add that while they teach the lesson, a few learners turn on their tablets without displaying the screen to the educator (Celik et al., 2017a; Varier et al., 2017). The educator cannot control what the learners are doing, as some educators found learners playing racing games or basketball while teaching (Celik et al., 2017a; Varier et al., 2017). The educator is forced to check the learners individually without doing anything on the board, a time-consuming exercise (Celik et al., 2017a; Varier et al., 2017). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study as elements that both help or prevent the effectiveness of schoolroom management. This research intends to comparatively investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore.

Accessibility to resources comprises one of the imperative forerunners for utilising ICT in a lesson (Drossel et al., 2017). The lack of specialised support, pedagogical support, and any other deficiency regarding helping has been distinguished as one more hindrance at the school level for educators utilising ICT (Drossel et al., 2017). Deficient circumstances concerning time, yet an absence of similarity with the curriculum, have pertinent deterrents regarding the execution of ICT at school, as observed by educators in secondary schools (Drossel et al., 2017; Varier et al., 2017). Various discoveries show

that inadequate material forestalls ICT utilisation with regard to teaching-learning practices (Eickelmann et al., 2017). Learners prefer writing paper-based Mathematics tests over those taken on digital devices since they were uncertain whether the gadget would dependably record answers (Varier et al., 2017). Learners complain about the absence of keyboard and keypad limitation capacities in tablet gadgets, making writing Mathematics tests that require working difficult and inconvenient (Varier et al., 2017).

Generally, past investigations cannot convincingly say in which conditions at the school level there is a positive relationship between ICT utilisation and learners' effective learning (Eickelmann et al., 2017). The non-convincing positive relationship implies that a more continuous and frequent ICT utilisation at school correlates with lower performance (Eickelmann et al., 2017). However, there are no detected negative impacts of the utilisation of PCs for the school teaching of Mathematics on learners' performance in Singapore, Norway, and Australia (Eickelmann et al., 2017). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore.

Learners report that they are often distracted in flexible space schoolrooms (Kariippanon et al., 2019). The distraction is a direct result of the expanded attention on collaboration, with learners being urged to deliberate with friends about what they learn in class, without them fundamentally having the self-restraint to remain on the topic

(Kariippanon et al., 2019). Getting distracted was additionally encouraged by the format and furniture arrangement (Kariippanon et al., 2019). With the liberty to work in various places, such as a detached corner or in the passage, learners ended up being noticed less by the educator and all the more quickly flustered by their friends (Kariippanon et al., 2019). Learning space that is flexible regularly can hold a more significant number of learners than a conventional schoolroom. An open plan does not have dividers to give spaces that are isolated (Kariippanon et al., 2019). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore.

Possible Solutions for some Challenges of School-related Resources

To prevent learners from utilising tablet PCs for out-of-class undertakings, some settings can be technically adjusted to lock tablet PCs for the duration of the lesson (Celik et al., 2017a). To provide an interactive whiteboard, more programmes that are interactive ought to be developed (Celik et al., 2017a). What could facilitate ICT incorporation would be the availability and accessibility of an ICT school’s policy plan that constitutes the school's vision (Drossel et al., 2017). Advanced training undertakings offered to educators concerning the ICT integration in schoolrooms, for example, professional development exercise that is school-based, would possibly help (Drossel et al., 2017). Collaboration at the school level promotes educators' utilisation of PCs in schoolrooms (Drossel et al., 2017).

Notwithstanding the importance of IT material for schools to support PC-based teaching-learning methods, the assumption cannot be made that the amount of ICT resources in schools is useful (Eickelmann et al., 2017; Stoddard, 2014). Instead, it is the alignment of the pedagogy of the accessible IT material with the instructive objectives, just as the integration into Mathematics learning methods, that matters (Eickelmann et al., 2017). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore.

Challenges of flexible learning spaces could be overwhelmed with effective teaching practices and as learners turned out to be more familiar/accustomed to learning in flexible spaces. Eickelmann, Gerick and Koop (2017) make a good point that the usability and quality of new digital devices for teaching Mathematics should similarly be analysed with respect to ICT material proper for teaching-learning. Considering teaching-learning of Mathematics, ICT devices that are mathematics-specific, for example, handheld devices utilising subject-specific programming or graphics display calculators (GDCs), remove the requirement for desktop computers in the schoolroom, specifically in the event that they are not promptly accessible in the schoolroom (Eickelmann et al., 2017).

It is accepted that these challenges of flexible learning spaces could be overwhelmed with teaching practices that are effective as learners turn out to be more

familiar/accustomed to learning in flexible spaces (Kariippanon et al., 2019). It is recognised that educators and learners need help during the change stage/phase (Kariippanon et al., 2019). The availability and upkeep of facility resources and learning resources were featured in Juta and Van Wyk's (2020) study as elements that both help or prevent the effectiveness of schoolroom management. This research intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore.

Summary

The availability and upkeep of facility resources and learning resources were featured in Juta & Van Wyk's (2020) study as elements that both help or prevent the effectiveness of schoolroom management. This study intends to investigate school-related resources as determinants of Mathematics achievement among IBDP learners in South Africa and Singapore. There is a significant disparity in achievement between IBDP schools in Singapore and South Africa (Sin & Straits, 2017). However, IBDP schools in Singapore top the world in external examinations (Ang, 2020). From the literature review, the researcher found that a successful school provides a bunch of organised experiences, allowing learners to develop mentally, provides facilities to create supportive learner-groups that can be continued over the long run, encourages learners to take part in activities and clubs that strengthens their relationship with the school and to one another.

A successful school opens doors for learners to work in groups, encourages a feeling of connection and community, encourages learners to follow their interests, and promotes learning more about themselves through service (CAS), activities, creativity,

sports, and arts. A successful school encourages learners to take on positions of authority in learner government, sports, clubs, or different undertakings, permitting them to build self-confidence in various roles and circumstances. A successful school cultivates self-knowledge by offering open doors for learners to reflect on areas of a strong point and embrace territories they might want to improve. It provides an opportunity for learners' autonomous choice-making through components of the IBDP, for example, CAS, the extended essay, and the theory of knowledge (Barnett, Avila & Aklog, 2017). The IB gives high-quality education and promotes global-mindedness among educators, learners, and administrators (Beckwitt et al., 2015).

An unanswered question remains if the performance of the IBDP Mathematics groups in South Africa and Singapore is attributed to school-related resources as determinants. Even though there were enormous studies, such as TIMSS and PISA, conducted in South Africa and Singapore to determine the influence of resources on Mathematics performance, they were conducted in lower-aged groups and never carried out on the progressive groups like the IBDP Mathematics learners. Singapore topped all the countries, although it had exclusion from the TIMSS study, such as its private schools. They predominantly offer foreign curricula (for example, the IB curriculum), which are foreign systems (Laroche & Foy, 2016). Hence, there was a need to conduct this research in IB Diploma Mathematics in South Africa and Singapore. The current research focuses on an area never included in TIMSS studies in Singapore and South Africa: the IBDP schools. TIMSS advanced was never been conducted in Singaporean and South African soils since the inception of the TIMSS study in 1995 (National Centre for Education

Statistics, n.d.-a). My original contribution to knowledge is my exploration of school-related resources as determinants of Mathematics achievement among IBDP learners doing Mathematics Analysis and Approaches (Mathematics AA) in South Africa and Singapore.

From the review, we deduced that IB learning is inquiry-based and concept-driven, giving learners numerous advantages whenever executed well (Dickson et al., 2017). Inquiry-based education advances profound learning and engagement. It encourages a motivating and challenging learning climate, which learners esteem in all achievement levels. The literature showed that successful learning is a multi-faceted undertaking that requires equal amounts of educators' and learners' energy. The relationship between educator efforts and learner results will eventually reveal the effectiveness of the school in preparing learners to flourish educationally, first to acquire their secondary school diplomas, and lastly, their college degrees (Holman et al., 2015; Saavedra, 2014b; Sanders & Ishikura, 2018). Both academic and non-academic staff work toward achieving the same goal: to produce good school performance in learners. Academic and non-academic staff are the significant categories of personnel in a school (Aja-Okorie, 2017). The school personnel improves the scholastic participation, performance, and interest of the learners’ education.

The school's academic quality relies straightforwardly upon the educators' capacity, responsibility, inspiration, and a significant number of non-academic staff. The educator, not the curriculum, makes the teaching-learning practice more effective. The educator and his teaching method is a critical factor in deciding the performance of the

learner. Aspects of educators like level of education, experience in the teaching profession, and interest they have in teaching have an effect on learner achievement. A good Mathematics educator, according to learners' perception, is somebody who clarifies Mathematics well. The literature review showed that offering IB programmes in public schools in Africa is a big challenge (Hill, 2018). In a few African countries, there are a small bunch of 'tip-top' public schools with suitable class sizes, excellent educators, and no educational expenses. These are a small fraction of all public schools where class sizes, including the final year of school, can be from 60 to 90 learners with no accessibility to textbooks without stationery. Few educators are teaching jobs because remunerations have not been paid for a while (Hill, 2018).

As the study is anchored and informed by the first stage of Maslow's hierarchy of needs, the literature reviewed some physiological needs explored in relation to achievement in Mathematics under school-related resources. Teaching-learning resources are imperative in the academic field and should be integrated into the lesson to attain the best accomplishment. Teaching-learning resources are a subset of instructive technologies. The call for integration of technology implies that there should be a transparent integration approach of technologies in the lesson whenever we talk about teaching and learning. The literature review found two types of educational resources, namely human and material resources, organised for teaching-learning purposes (Mnuabueze, 2016). They are grouped into resources that might be physical (building structures, space and so forth), human (scholarly and non-scholastic personnel), material (all equipment or teaching-learning aids and so on), and finances alongside

programmes accessible in schools. Successful teaching-learning of Mathematics relies on the effective utilisation of teaching resources. Technologies can help reach top achievement or poor performance depending on how they are utilised in a lesson. The utilisation of technology is a vital component of learners' educational attainment. However, any technological tool, when wrongly used, might yield negative results.

In contradiction to the literature review, the use of ICT teaching-learning resources has a negative effect if not properly monitored. Research confirms that ICT increases the probability of being distracted and performing multiple tasks, negatively affecting educational achievement. For good experience in the teaching-learning practice in the schoolroom, learners ought to be exposed to essential learning principles. PCs and ICT material resources utilisation correlates with good achievement and poor performance in learners. Availability and accessibility of digital devices are determining factors if ICT use in schoolrooms will have a lasting effect on performance. Technology should be used as a vehicle and driven by pedagogy in Mathematics education. Social media platforms are easy to use as they are easily accessible to all learners in a schoolroom. However, the use in a particular manner and not the ownership of the PCs has an effect. Computer facilities provided for Matric Mathematics classes in South Africa for the Khanya project in the Western Cape have not improved Matric Mathematics grades. The lack of improvement could only demonstrate that this mediation is not enough to have any effect in isolation.

It was further observed from the literature review that Graphic Display Calculators (GDCs) enhance performance in Mathematics education. Throughout the century, digital

technology has been demonstrated to be one of the significant apparatuses for progression in schooling. Calculator utilisation in Mathematics learning helps learners in problem-solving explorations, verifications, calculations, and representations. The utilisation of technology in education can encourage learners to learn. Calculators can enhance the inductive intuition process if educators know how to utilise them. Textbooks are a significant contribution to achievement in assessments. Excellent textbooks present more than Mathematics content yet propose ways of interaction for learners and educators and build meanings from it. The learning surroundings or physical facilities directly affect learner performance. For the most incredible learning experience to occur, the school surroundings and the schoolrooms must be in their best condition (Gain & Ancho, 2019). Learning limit and achievement rely on the state of being of the space learners are in, not only upon the individual factors, for example, inspiration, mental conditions and insight (Kasım & Rengin, 2018; Widiastuti et al., 2020).

Teaching resource-materials incorporate visual audio, television, computers, and charts materials. The use of audio-visual resources improves learners' performance. Video recordings, therefore, are a famous device utilised in engaging learners and improving their learning experiences (Costa et al., 2020; Olagbaju & Popoola, 2020; Oviawe & Uddin, 2020; Quevedo et al., 2017; Stohlmann & Acquah, 2019). The utilisation of video recordings as Mathematics learning media assumes a function incomprehension of the lessons, improving learners' performance, improving learners' knowledge, and improving learners' inspiration. Furthermore, the utilisation of video recordings permits learners to learn at their speed and urges learners to participate in the teaching-learning

practice effectively. It opens up real schoolroom time for more active, creative, and effective learning exercises, educators get extended chances to collaborate with and evaluate learners' learning, and learners assume control and accountability for their learning (Costa et al., 2020; Nouri, 2016; Stohlmann & Acquah, 2019).

The second theoretical framework of the current study, Greg Kearsley's Theory of Engagement, gives a solid framework for exploring possibilities of good academic performance through availability, accessibility, and utilisation of school-related resources through schoolroom collaboration, engagement, and participation. My original contribution to knowledge is the outcome of my comparative investigation of school-related resources as determinants of Mathematics performance among IBDP Mathematics AA learners in South Africa and Singapore doing year 2 (IBDP 2). The IBDP Mathematics AA was being examined for the first time in 2021 external examinations as a new Mathematics course in IBDP.

CHAPTER 3: RESEARCH METHOD

Introduction

Education has assumed a vital part in the supportability of human societies for some time in the past and the education system (Vakili & Pourrazavy, 2017). Therefore, educational accomplishment is an issue that, each year, dedicates a gigantic measure of exploration to itself, and the variables influencing it have drawn into consideration psychologists in Education and other education experts for quite a long time (Vakili & Pourrazavy, 2017). The research methods and data collection chapter describe the research methods utilised in the current study. Chapter three is organised into an introduction, research methodology, methods, definitions, types of causal-comparative research, steps for conducting causal-comparative research, design of causal-comparative research, methods and procedures utilised to address the research questions, methods and procedures utilised to repeat the investigation, instrument, threat to validity, reliability, sampling, types of control techniques, data analysis, and summary.

The purpose of this correlational method research design study is to find The difference in the availability of school-related resources to IBDP 2 learners in South Africa and Singapore; The difference in the accessibility of the school-related resources of IBDP 2 Learners in South Africa and Singapore; The difference in the school-related resources utilisation of IBDP 2 Learners in South Africa and Singapore; The difference in the Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore; Relationship between school-related resources availability and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore; Relationship between

school-related resources accessibility and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore; Relationship between school-related resources utilisation and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore. The data collection period is from 01 February 2022 to 31 May 2022.

Research Methodology

Methods

In terms of purpose, the current research is an applied exploration and a part of advancement, and as far as the nature and technique, it is correlational research.

Definitions

Correlational research includes gathering data to investigate how much a relationship exists between at least two variables and exploring the variables' implications for causes and effects (Fraenkel & Wallen, 2022). Correlational research can assist us with making more astute forecasts. Correlational research methodology requires no intervention, manipulation or intercession concerning the researcher except for administering the tool essential for collecting the data (Fraenkel & Wallen, 2022). By and large, one would attempt this kind of exploration to search for and depict associations that might exist among natural happening peculiarities without attempting in any capacity to adjust these peculiarities. (Fraenkel & Wallen, 2022; Fraenkel, Wallen & Hyun, 2012). Therefore, correlational research is relationship research similar to causal-comparative studies, as both depict existing conditions (Apuke, 2017; Fraenkel & Wallen, 2022; Fraenkel, Wallen & Hyun, 2012; Ibanez et al., 2021). Correlational exploration is

conducted for one of two fundamental reasons: to assist with making sense of significant human behaviour or to predict likely results.

The nature of correlation research

The correlational study finds relationships among variables (Apuke, 2017; Fraenkel & Wallen, 2022; Fraenkel et al., 2012). The significant trait of correlational exploration is searching out relationships among variables. Correlational studies, as causal-comparative explorations, illustrate what is, in some cases, called associational research (Fraenkel & Wallen, 2022). In associational studies, the relationship among at least two variables is studied with no endeavour to influence the variables. In their least complex structure, correlational explorations research the chance of associations between just two variables, even though studies of multiple variables are common (Fraenkel et al., 2012). Again, as opposed to experimental research, be that as it may, there is no control of variables in the correlational research.

Correlational exploration is likewise once in a while alluded to as a type of descriptive research since it portrays a current association between variables (Fraenkel et al., 2012). How it depicts this relationship, be it as it may, is not quite the same as the portrayals tracked down in different research (Fraenkel et al., 2012). When utilising the correlation coefficient (R), correlational research depicts how much at least two quantitative variables are associated. At the point when a relationship is found to exist between two variables, it implies that scores inside a specific range on one variable are related to scores inside a specific range on the other variable. A positive relationship implies that high scores on one variable will more often than not be related to high scores

on the other variable. In contrast, low scores are related to low scores on the other. A negative relationship, then again, implies that high scores on one variable are related to low scores on the other variable and low scores on one are related to high scores on the other. Correlational studies are conducted either to assist with making sense of significant human actions or to predict possible results (Fraenkel et al., 2012). Suppose an association of appropriate degree exists between two variables. In that case, it becomes conceivable to foresee an unknown dependent variable score when the corresponding independent variable's score is known. In correlational research, scatterplots and regression lines are utilised to predict a dependent variable score on an independent variable (Fraenkel et al., 2012).

The coefficient of determination

The square of the correlation coefficient (R) is called the coefficient of determination (R^2) (Fraenkel & Wallen, 2022). It designates the extent of variation common to two variables. So, the coefficient of determination shows the percentage of fluctuation among the dependent variable scores that can be ascribed to contrasts in the scores on the independent variable.

Steps for Conducting Correlational Research

Most studies incorporate problem selection, sample selection, questionnaire selection or development, procedure determination, data collection and analysis, and results interpretation (Fraenkel & Wallen, 2022). For example, comparing the Mathematics achievement of IBDP 2 learners in South Africa and Singapore, comparing them with other variables (for example, availability, accessibility, and utilisation of school-

related resources) in selected IBDP schools in South Africa and Singapore. As most scholars point out, the sample size of a correlational study should not be less than 30 (Fraenkel & Wallen, 2022). A wrong estimate of the degree of association might be obtained from data from less than 30 sample sizes (Fraenkel & Wallen, 2022). Meaningful results are considerably more prone when obtained from sample sizes over 30.

Data analysis and interpretation

A correlation coefficient (R) between 0 and ±1 is created when variables are correlated. When the coefficient is closer to ±1, the stronger the association. Assuming the sign is negative, the relationship is negative, demonstrating that high scores on one variable often go with low scores on the other. Assuming the sign is positive, the relationship is positive, demonstrating that high scores on one variable generally go with high scores on the other. A coefficient at or close to zero demonstrates no relationship between the variables. A correlation coefficient less than 0.35 ($0 \leq |R| < 0.35$) shows only a slight or no association between the compared variables (Fraenkel & Wallen, 2022). Such relationships have practically no worth in any prescient sense. Correlation between 0.35 and 0.7 ($0.35 \leq |R| < 0.7$) demonstrates a weak to moderate relationship (Fraenkel & Wallen, 2022). Relationships between 0.4 and 0.6 are often tracked down in educational research and may have hypothetical or reasonable worth, contingent upon the specific circumstance. A relationship of 0.65 or higher will permit precise predictions for most situations. While a correlation coefficient that is greater than 0.7 ($0.7 \leq |R| \leq 1$) demonstrates a strong relationship between compared variables (Fraenkel & Wallen, 2022). Relationships greater than 0.85 show a very close association between the

correlated variables and are helpful in predictions. However, relationships this high are seldom obtained in educational studies except for reliability checking (Fraenkel & Wallen, 2022). The correlation coefficient is called the reliability and validity coefficient when used to check the reliability and validity of scores obtained from research instruments used in studies (Fraenkel & Wallen, 2022). Some scholars believe the reliability coefficient should be 0.7 or more (Fraenkel & Wallen, 2022). In contrast, the validity coefficient should be 0.5 or more (Fraenkel & Wallen, 2022). For the current study, reliability was tested in the PSPP statistics program, giving Cronbach alpha of 1.0 overall. The validity of the questionnaire was tested in the PSPP statistics program, using a two-tailed test bivariate correlation at $\alpha = 0.05$, where 93% of the questionnaire items were valid.

Procedures

Before the data collection for the main study, a field test was conducted in South Africa and Singapore. Checking the instrument used and operating procedures employed in the same settings as those of the main study are part of the objectives of the field test. The sample size of the field test was 60 IBDP 2 learners doing IBDP Mathematics AA courses. To guarantee the uniformity and consistency of the fundamental approach for superior quality, the researcher administered the questionnaires to respondents online, utilising similar procedures. The advantages of the online survey comprise saving time and money in reproduction and refining the efficacy of questionnaires dispersion, data cleaning and entry (Johansone, 2015). For the online survey, the questionnaires were presented directly to the respondents. Therefore, the online questionnaire did not allow the respondents to move on to the next page if an item was not fully answered. However,

the questionnaire could be accessed with standard internet browsers on a typical operating system using the link sent to the learners' school emails without the respondent requiring any extra software. Furthermore, the online system allows the researcher to monitor the questionnaire responses continuously to follow up on non-respondents (Johansone, 2015).

The following procedure was followed in the current study: The first step was the sampling of schools in Singapore, where five schools were used in the main study, and the sixth and seventh schools were used as substitute schools in case there was a school that refused to participate in the main study, and finally, the eighth school was used in the field test. All seven schools in Singapore were sampled with the primary study sample using stratified random sampling. In South Africa, all the IBDP schools were incorporated in the main study as the schools were too few to be sampled. One school was selected through a simple random sampling method and used in the field test in South Africa. Letters asking for permission to conduct the study in South Africa were sent to the Department of Education of each province where there was a participating school in South Africa. The same letter was sent to the Ministry of Education in Singapore. A letter was also sent to the participating schools' school principals and gatekeepers. Respondents were given consent and assent forms to sign to indicate willingness to participate in the study.

The second step followed in the current study was conducting the field test. School emails of all learners who agreed to participate in the study were obtained from the school gatekeepers. Learners from the schools selected for the field test were emailed a link to

the questionnaire. The third step followed in this research was collecting the main study's data. The fourth step followed was that of scoring the Constructed Response Items. The fifth step was data capture and creating the database. SPSS and other software were used for data capture.

Survey tracking forms

The current research uses a tracking form to track learner information, school, document sampling procedures, and the participation position of the learners (Johansone, 2015). The tracking form also facilitated data verification and collection. However, the current research uses only one tracking form, the Class Listing Form. The records were filled with detailed class information for all sample schools where eligible learners were listed. For example, learners' school emails were listed on the form and the number of learners.

Instrument

There are no restrictions on the instruments utilised in correlational research (e.g. observational devices, attitudinal measures, interview schedules, questionnaires, and achievement tests) (Fraenkel et al., 2012). However, the data collection method for the current research incorporates an online survey. In the present study, the questionnaire is a data collection tool utilised. The reliability of the questionnaire was calculated using Cronbach's alpha (Vakili & Pourrazavy, 2017).

The instrument used in the current study is a questionnaire. The questionnaire uses pre-existing items adopted mainly from Trends in International Mathematics and Science Study (TIMSS) Advanced 2015. The TIMSS Advanced 2015 is a worldwide study

that has been comparatively conducted by the International Association for the Evaluation of Educational Achievement (IEA) since 1995 (Malley & Provasnik, 2021; TIMSS & PIRLS, 2021). The questionnaire was administered online to seven South African and Singapore-sampled schools. There were six schools for the main study and two for the field study among the seven sampled schools. One school in South Africa was tested in field tests and the primary survey because all the IBDP schools in South Africa are part of the current study sample. The survey was conducted from 1 February 2022 to 30 April 2022. The researcher first sent learners' consent forms to IB Diploma Coordinators (gatekeepers) to email to all final-year IBDP learners doing IBDP Mathematics AA courses. The researcher acquired their school email accounts from the IBDP Coordinator for the learners who agreed to participate. The questionnaire was then administered online to all learners who participated in the current study.

The questionnaire has 170 items. The items consist of demographic, performance, and contextual items. The most effective school is not just a gathering of discrete qualities but a well-managed, coordinated system where each activity or policy influences any remaining parts (Malley & Provasnik, 2021). The current study highlights well-informed school quality markers, such as instruction impacted by resource deficiencies, school composition by learner financial foundation, and school environment. Hence, the current comparative study looks at the availability, accessibility, and utilisation of school-related resources as determinants of performance for IBDP 2 learners in the IBDP Mathematics AA courses. The scoring of the questionnaire items was more straightforward because online questionnaires were used in the current study. In addition, the data were directly

accessible to be entered into statistical analysis software (SPSS). Therefore, there was no further manually required data entry.

To guarantee confidentiality, the researcher emailed all respondents an access link and detailed information on the best way to access the online questionnaire. The login details corresponded to the respondent's ID, implying that the respondent's identity was validated when the respondent signed in to the questionnaire. Since the data were gathered online and put away straightforwardly on the researcher's Google Drive, data was not required to be entered manually, thus lessening the researcher's workload. An additional benefit of the online questionnaire was that the data would generally have fewer irregularities than data collected through paper-based surveys.

The fewer irregularities are relative because the online-based questionnaire does not permit conflicting responses. For instance, assuming the item requests that the respondent "Select one square for each line," the online questionnaire would not allow the respondent to select several options on each item. Moreover, the current research questionnaire has various items that channel out respondents, which means the following items are non-applicable given the selection of the channel questions. For instance, Question 13a of the questionnaire peruses "A. During the last 12 months, have you attended extra lessons or tutoring notprovided by the school in IBDP Mathematics AA? If Yes, B. Why did you attend these extra lessons or tutoring? If a respondent picks "No", the web-based questionnaire jumps straightforwardly to the next question, precluding Question 13. B (a), 13. B (b), and 13. B (c). Not only does the skip rationale save the participating learners' time, but it likewise brings about fewer irregularities in the data

submitted to the researcher. There were no invalid, omitted or not reached items in the online questionnaire because the online system did not allow respondents to move to the next question when the previous question was not fully answered. Furthermore, it did not allow respondents to submit an incomplete questionnaire.

Questionnaire scaling

Learners like learning the IBDP Mathematics AA course scale.

As the name recommends, this scale gauges learners' sentiments towards learning the IBDP Mathematics AA course. There were 38 items for the Learners Like Learning IBDP Mathematics AA Courses scale. In these 38 items, respondents were requested to show the level of their concurrence with the assertion: strongly agree to disagree strongly. Utilising item response theory (IRT) partial credit scaling (Mullis & Hooper, 2015a), the learner-response data were set on a scale built to ensure that a ten-point-centre scale was situated at the mean score across the two countries. The scale units were picked, so two scale-score points correspond relatively to the standard deviation in the two countries. Items stating negative feelings were conversely coded during the scaling (for example, items 17(c), 17(f), 17(k), 18(c), and 18(f)). Learners that Very Much Like Learning IBDP Mathematics AA Course had 11.8 or more points on the scale (set by the researcher) (Mullis & Hooper, 2015a), which corresponds with strongly agreeing, by and large, with 19 of the 38 items and concurring a little with 19 of the items. Learners who Do Not Like Learning Mathematics AA Course had 9.1 or fewer points on the scale (set by the researcher) (Mullis & Hooper, 2015a), which corresponds with disagreeing a little with 19 items, by and large, and agreeing to a little with 19 of them.

Availability of school-related resources for learning IBDP Mathematics AA course scale.

This scale tries to gauge the availability of school-related resources for learning the IBDP Mathematics AA courses. Nine items were for the Availability of School-related Resources for Learning IBDP Mathematics AA courses Scale. For each of these nine items, learners were requested to show the level of their concurrence with the assertion: strongly agree to disagree strongly. Utilising item response theory (IRT) partial credit scaling (Mullis & Hooper, 2015a), the learner-response data were set on a scale built to ensure that a ten-point-centre scale was situated at the mean score across the two countries. The scale units were picked, so two scale-score points correspond relatively to the standard deviation in the two countries. Items stating negative feelings were conversely coded during the scaling (for example, items 30 and 31). Availability of school-related resources for the Learning IBDP Mathematics AA Course had 11.8 or more points on the scale (set by the researcher) (Mullis & Hooper, 2015a), which corresponds with strongly agreeing, by and large, with five of the nine items and concurring a little with four of the items. Learners with school-related resources for Learning Mathematics AA Course had 9.1 or fewer points on the scale (set by the researcher) (Mullis & Hooper, 2015a), which corresponds with agreeing to a little with four items, by and large, and disagreeing a little with four of them.

Accessibility of school-related resources for learning IBDP Mathematics AA course scale.

This scale tries to gauge the accessibility of school-related resources for learning the IBDP Mathematics AA course. There were ten items for the Accessibility of School-related Resources for Learning IBDP Mathematics AA Courses scale. In these ten items, learners were asked to show their concurrence level with the assertion: strongly agree to disagree strongly. Utilising item response theory (IRT) partial credit scaling (Mullis & Hooper, 2015a), the learner-response data were set on a scale built to ensure that a ten-point-centre scale was situated at the mean score across the two countries. The scale units were picked, so two scale-score points correspond relatively to the standard deviation in the two countries. Accessibility of school-related resources for Learning IBDP Mathematics AA Course had 11.8 or more points on the scale (set by the researcher) (Mullis & Hooper, 2015a), which corresponds with strongly agreeing, by and large, with five of the ten items and concurring a little with five of the items. Learners that have access to school-related resources for Learning Mathematics AA Course had 9.1 or fewer points on the scale (set by the researcher) (Mullis & Hooper, 2015a), which corresponds with disagreeing a little with five items, by and large, and agreeing to a little with five of them.

The utilisation of school-related resources for learning the IBDP Mathematics AA course scale.

This scale tries to gauge the utilisation of school-related resources for learning the IBDP Mathematics AA course. There were seven items for the Utilisation of School-

related Resources for Learning IBDP Mathematics AA Courses scale. In these seven items, learners were requested to show the level of their concurrence with the assertion: strongly agree to disagree strongly. Utilising item response theory (IRT) partial credit scaling (Mullis & Hooper, 2015a), the learner-response data were set on a scale built to ensure that a ten-point-centre scale was situated at the mean score across the two countries. The scale units were picked, so two scale-score points correspond relatively to the standard deviation in the two countries. As a result, the utilisation of school-related resources for the Learning IBDP Mathematics AA Course had 11.8 or more points on the scale (set by the researcher) (Mullis & Hooper, 2015a), which corresponds with strongly agreeing, by and large, with four of the seven items and concurring a little with three of the items. On the other hand, learners who used school-related resources for Learning Mathematics AA Course had 9.1 or fewer points on the scale (set by the researcher) (Mullis & Hooper, 2015a), which corresponds with disagreeing a little with three items by and large and agreeing to a little with 3 of them.

Partial credit item response theory (IRT) scaling is established on a statistical model that tells the likelihood that an individual will pick a specific response to an item to that individual's location on the primary construct. For example, in the questionnaire, Students Like Learning IBDP Mathematics AA Course scale, availability of school-related resources for learning IBDP Mathematics AA course scale, accessibility of school-related resources for learning IBDP Mathematics AA course scale, and utilisation of school-related resources for learning IBDP Mathematics AA course scale, the basic constructs are learners' attitudes towards learning IBDP Mathematics AA course, availability to

learners, accessibility to learners, and utilisation by learners of school-related resources respectively. Learners, for example, who concur with the attitude statements are expected to be more interested in learning the IBDP Mathematics AA course. In comparison, learners who cannot agree with the attitude statements are accepted to have less interest.

The function below displays the partial credit model (Mullis & Hooper, 2015a, p. 245):

$$P_{x_i}(\theta_n) = \frac{e^{\sum_{j=0}^{x_i}(\theta_n - \delta_i + \tau_{ij})}}{\sum_{k=0}^{m_i} e^{\sum_{j=0}^{x_i}(\theta_n - \delta_i + \tau_{ij})}} \quad x_i = 0, 1, ..., m_i$$

Where $P_{x_i}(\theta_n)$ represents the likelihood that an individual n with location θ_n on the hidden construct would pick a response level x_i to the item inconceivable response levels. As for the item parameters τ_{ij}, it provides the position of the item on the latent construct and τ_{ij} indicates parameter steps in the response's levels. The scaling procedure in each scale, initially includes assessing the item parameters δ_i and τ_{ij}, afterwards, utilising the model with these boundaries to gauge the value of θ_n, which is, the value of the hidden construct in each of the n respondents.

The current research questionnaire scaling was done utilising the ConQuest 2.0 programming (Mullis & Hooper, 2015a). All response items valid to no less than two on a scale were incorporated into the scoring and calibration processes.

Achievement Scores Transformation Scale

The scaling of the raw scores (*see Table 1*) was adapted from the grade boundaries close to those used by the International Baccalaureate Organisation (IBO) in Mathematics AA external examinations every year. The raw scores item was used to check the reliability of the Mathematics grade item, scored from 1 to 7, which are grades used by the International Baccalaureate Organisation.

Table 1

Equivalence Table of the Raw Score and Transformed to IBO Scale Scores

Transformation Scale of Raw Scores	Transformed to IBO Scale Score
0 to 9	1
10 to 29	2
30 to 39	3
40 to 59	4
60 to 69	5
70 to 89	6
90 to 99	7

Instruments

The first part of the questionnaire had a cover letter and consent information for participants. Section one had eight demographic questions. It also contained learners' sentiments towards learning the IBDP Mathematics AA course. There were 38 items for the Learners Like Learning IBDP Mathematics AA Courses scale in section one. Section

two had items on the availability of school-related resources for learning the IBDP Mathematics AA courses. There were nine items for the Availability of School-related Resources for Learning IBDP Mathematics AA courses Scale in section two. Section three contained items on the accessibility of school-related resources for learning the IBDP Mathematics AA course. There were ten items for the Accessibility of School-related Resources for Learning IBDP Mathematics AA Courses scale in section three. Section four contained items on utilising school-related resources for learning the IBDP Mathematics AA course. Section four contained seven items for the Utilisation of School-related Resources for Learning IBDP Mathematics AA Courses scale. Finally, section five contained an open-ended question to allow respondents to provide any additional information they have that is relevant to the current study.

Threats to validity

The absence of randomisation and powerlessness to manipulate the independent variable are two shortcomings in correlational studies (Fraenkel et al., 2012). Internal validity's significant threat to correlational research is the likelihood of biases in sample selection (Fraenkel et al., 2012). The central systems a researcher can utilise to lessen this danger include matching research participants on a related variable, making homogeneous smaller groups, and utilising statistical matching. Internal validity threats in correlational research include losing subjects, instrumentation, and location (Fraenkel et al., 2012). Moreover, type 3 explorations depend upon execution, testing threats, regression, the attitude of subjects, history, and implementation (Fraenkel et al., 2012).

The quality of the instrument utilised in research is vital for the researcher's conclusion on the data they acquire (Fraenkel et al., 2012). Appropriately, a researcher uses various methodologies to guarantee that the researcher's inferences are reliable and valid in light of the data gathered (Fraenkel et al., 2012). The validity of an instrument alludes to the suitability, weightiness, accuracy, and value of the researchers' inferences (Fraenkel et al., 2012). On the other hand, the reliability of an instrument alludes to the uniformity of responses or scores obtained from a set of items in an instrument, irrespective of the number of times a questionnaire is administered or the number of different groups of items administered by the researcher (Fraenkel et al., 2012). The researcher knows that an instrument can be reliable, although not valid.

The significant part of validity as signs of adequate settings and conditions for learning was the positive relationship between TIMSS Advanced 2015 global context questionnaire scales and performance (Mullis & Hooper, 2015b). In addition, Pearson correlation with IBDP Mathematics AA course achievement for South Africa and Singapore and R-squared, the ratio of variance in performance owing to the Learners Like Learning Mathematics scale was also used in the current study (Mullis & Hooper, 2015b).

Reliability test

Reliability alludes to the consistency of responses or scores obtained from an instrument and a set of items irrespective of the number of times a questionnaire is administered or the number of different groups of items administered by the researcher (Fraenkel et al., 2012). In addition, the instrument's reliability alludes to the uniformity of

the responses or scores acquired and the scores' consistency when the instrument and set of items are administered several times to the same individual (Fraenkel et al., 2012).

Since measurement mistakes are consistently present, researchers anticipate some difference in test scores when administering the same instrument to the same group at least twice (Fraenkel et al., 2012). Estimates of reliability give researchers a clue of how much disparity to anticipate (Fraenkel et al., 2012). Such reliability estimates are typically communicated as one more utilisation of the relationship coefficient known as a reliability coefficient (Fraenkel et al., 2012). A reliability coefficient likewise conveys an association; however, it is between scores on two areas of the same questionnaire or the same questionnaire on two distinct occasions of the same persons (Fraenkel et al., 2012). The internal consistency, the equivalent forms, and the test-retest are the three most popular methods of acquiring a reliability coefficient (Fraenkel et al., 2012). The reliability coefficient range should be 0 to 1, without negative values (Fraenkel et al., 2012).

When two distinctive yet equivalent (likewise called parallel or alternate) types of a questionnaire are given to the same set of individuals during a similar time frame, it is called the equivalent-form method (Fraenkel et al., 2012). Although the items are unique, they should test a similar substance and be developed independently from one another (Fraenkel et al., 2012). The reliability coefficient is then determined between the two sets of scores acquired (Fraenkel et al., 2012). A high-reliability coefficient would indicate a solid proof of reliability (Fraenkel et al., 2012). Coefficients of reliability will be influenced by the time allotment that slips between the two administrations of the tests (Fraenkel et al., 2012). The more extended the time stretch, the lower the reliability coefficient since

there is a more substantial probability of changes in the people taking the survey (Fraenkel et al., 2012). Therefore, a reasonable period should be chosen to check for reliability proof of test-retest (Fraenkel et al., 2012). This span ought to be during which people would be expected to hold their overall position in a group (Fraenkel et al., 2012).

All the techniques referenced so far require double testing periods. However, a few internal consistency methods for assessing reliability quality require just a solitary administration of a questionnaire (Fraenkel et al., 2012). For example, the split-half process could determine an instrument's internal consistency (Fraenkel et al., 2012). The split-half includes scoring two parts (typically even items versus odd items) of a questionnaire independently for every individual and then, at that point, computing a correlation coefficient for the two groups of scores (Fraenkel et al., 2012). The coefficient shows how much the two parts of the test give equivalent outcomes and consequently depicts the internal consistency of the questionnaire (Fraenkel et al., 2012). The Spearman-Brown prediction equation determines the reliability coefficient (Fraenkel et al., 2012).

$$\text{Reliability of scores on total test} = \frac{2 \times \text{reliability for } \frac{1}{2} \text{ test}}{1 + \text{reliability for } \frac{1}{2} \text{ test}}$$

(Fraenkel et al., 2012, p. 156)

The reliability of a questionnaire can be improved by adding more items if they are like the first ones (Fraenkel et al., 2012). The Kuder-Richardson approach may be the most utilised technique for determining internal consistency (Fraenkel et al., 2012). The

Kuder-Richardson approach requires just three snippets of information: the standard deviation, the mean, and the number of items (Fraenkel et al., 2012).

$$\text{KR21 reliability coefficient} = \frac{K}{K-1}\left[1 - \frac{M(K-M)}{K(SD^2)}\right]$$

(Fraenkel et al., 2012, p. 156)

where K = number of items on the test, M = mean of the set of test scores, and SD = standard deviation of the set of test scores.†

For research purposes, a valuable guideline is that reliability ought to be at any rate of 0.70 and ideally higher (Fraenkel et al., 2012).

The current study questionnaire items were adapted from TIMSS Advanced 2015 global study context questionnaires (Mullis & Hooper, 2015b). The TIMSS Advanced International Study Context questionnaires were assessed after the field test to check the reliability and validity of the different scales of the questionnaires (Mullis & Hooper, 2015b). The reliabilities for the TIMSS Advance 2015 global study context questionnaires were generally high, with a worldwide median reliability coefficient of 0.88 (median value for all participating countries) in Mathematics (Mullis & Hooper, 2015b). The reliability coefficient is the median Cronbach's alpha reliability in all assessment instruments in TIMSS Advanced 2015 (Mullis & Hooper, 2015b).

A sampling of schools in Singapore and South Africa

The current study provides a reliable and valid comparison of IBDP 2 learners doing IBDP Mathematics AA courses in South Africa and Singapore while minimising the load on learners, educators, and schools. The current study utilises comprehensive

school and classroom sampling procedures to ensure that comparison in the learner population might be precisely estimated from the sampled schools by assessing only a sample of learners (Mullis & Hooper, 2015b). Carefully define the characteristics to be explored and select the groups that contrast with this trademark (Fraenkel et al., 2012). The triumph of correlational research relies significantly on how the comparison groups are characterised cautiously. Selecting homogeneous groups concerning some significant variables is important (Fraenkel et al., 2012). The selected groups can be matched on one or more variables once defined (Fraenkel et al., 2012). The matching process controls specific variables, removing any group contrasts on these variables (Fraenkel et al., 2012). The researcher needs the groups as alike as conceivable to clarify contrasts in the dependent variables because of group membership (Fraenkel et al., 2012).

Participants

The population in the current study is IBDP 2 learners doing IBDP Mathematics Analysis and Approaches courses with external examinations in 2022. There are 30 IBDP schools in Singapore and three IBDP schools in South Africa as of February 2022 (International Baccalaureate Organisation, 2022a; International Baccalaureate Organisation, 2022b). Therefore, samples should be as extensive as a researcher can get with reasonable time and energy (Fraenkel et al., 2012). The suggested least number of subjects is 30 per group for correlational and experimental studies, 50 for correlational studies, and 100 for descriptive studies (Fraenkel et al., 2012). The schools in Singapore were grouped according to the regions in which they are located. Singapore's five

political regions (see *Figure 6*) (World Atlas, 2022a) are Central, East, North, North-East, and West.

Figure 6

Five political regions of Singapore

Table 2

Number of IBDP Schools in all Regions of Singapore

Regions of Singapore	**Number of IBDP Schools**	**Number of Sampled Schools (main study)**	**Number of Learners**	**Number of Sampled Learners**
Central Region	22	1	47	10 – Higher Level 10 –Standard Level
East Region	2	1	39	10 – Higher Level 10 –Standard Level
North Region	1	1	45	10 – Higher Level 10 –Standard Level
North-East Region	1	1	37	10 – Higher Level 10 –Standard Level
West Region	4	1	44	10 – Higher Level 10 –Standard Level
Totals	30	5	212	50 – Higher Level 50 –Standard Level

For all the regions to be represented, the researcher sampled one school from each region to come up with five schools for the main study. The IBDP schools in Singapore are mainly populated in the Central Region (22 schools). The researcher used a simple random sampling technique to select two schools from the 22 schools from the Central Region, the first school for the main study and the second school for the field study. In the East region, there are only two IBDP schools. The researcher employed simple random sampling to select one school for the primary research, while the remaining school was reserved to be used in case the first one refused to participate in the main study. Since there was only one IBDP school in the North and North-East regions, the researcher used all the schools from these regions in the main study. The West region had four IBDP schools in total. The researcher used a simple random sampling technique to sample two schools, where the first school was used in the main study, while the second school was used as a substitute school if the first school refused to participate in the main study. There were eight sampled IBDP schools in Singapore (five for the primary research, two substitute schools, and one for the field study).

A stratified random sampling technique was employed in each of the five schools sampled for the main study to come up with ten learners doing the IBDP Mathematics AA Standard Level course and ten learners doing the IBDP Mathematics AA Higher Level course. A total of 20 learners from each of the five IBDP schools were selected to give 100 learners in Singapore (50 doing Mathematics AA Higher Level and 50 doing Mathematics AA Standard Level). Stratified random sampling was used in Singaporean

schools because there are two strata in IBDP Mathematics AA courses. Therefore, we needed only 100 learners to match the number of learners in South Africa.

Three IBDP schools in South Africa form part of the target population of the current study. Since the number of IBDP schools was minimal in South Africa, all three schools were automatically part of the main study. Among the three IBDP schools in South Africa, one IBDP school was used twice for field study and main study, while the others were used once. South Africa comprises nine provinces (see *Figure 7*) (World Atlas, 2022b). These provinces are the Western Cape, North West, Northern Cape, Mpumalanga, Limpopo, KwaZulu-Natal, Gauteng, Free State, and Eastern Cape.

Figure 7

Nine provinces of South Africa

There are two IBDP schools in Gauteng Province and one in Western Cape Province. No IBDP schools exist in the North West, Northern Cape, Mpumalanga, Limpopo, KwaZulu-Natal, Free State, and Eastern Cape (see *Table 2*).

Table 3

The Table below Indicates the Total Number of IBDP Schools in Each Province of South Africa

Provinces of South Africa	**Number of IBDP Schools in each Region**	**Number of Learners**	**Number of Sampled Learners**
Western Cape	1	17	7 – Higher Level 10 –Standard Level
North West	0		
Northern Cape	0		
Mpumalanga	0		
Limpopo	0		
KwaZulu-Natal	0		
Gauteng	2	81	39 – Higher Level 42 –Standard Level
Free State	0		
Eastern Cape	0		
Totals	3	98	46 – Higher Level 52 –Standard Level

There were approximately 100 learners from the combined three IBDP schools in South Africa. Due to the small sample size in South Africa, all three IBDP schools were

part of the main study. In addition, all the learners from both strata (IBDP Mathematics AA Standard Level and IBDP Mathematics AA Higher Level) were part of the primary study sample. Therefore, one of the three schools was used twice in the field and primary studies. The researcher constructed proper sampling weights for results analysis and reporting when data collection was completed.

Schools' recycling was similar to the global TIMSS Advanced study conducted in 2015. In Slovenia and Lebanon, all schools were part of the sample for the main study, and 48 schools in Lebanon and 29 schools in Slovenia were used for the field test and were part of the primary study sample of each country (LaRoche & Foy, 2015). In the United States of America, 72 schools were used in the main study and field tests, while in France, 32 schools were only used in the field test as they were not part of the main study sample in TIMSS Advanced 2015 (LaRoche & Foy, 2015). Schools from the field test were also used in the main study sample in Sweden and Norway, as there were no replacement schools in the TIMSS Advance 2015 study (LaRoche & Foy, 2015). Schools' recycling indicates that the same sample can be used in field tests and main surveys for data collection in rare circumstances. On the other hand, a separate sample not part of the main study sample could be used for the field test. Hence, the current study uses different samples in Singapore for the field test and the primary research, while in South Africa, one school is used twice for the field test and the main study.

Population generalisability alludes to how much a sample represents the research study population (Fraenkel et al., 2012). If a research study results possibly apply to the individuals being examined and if that group is minuscule or barely characterised, any

discoveries' helpfulness is truly restricted (Fraenkel et al., 2012). When the sample has been picked, all efforts should ensure that the required data are collected on every individual in the sampled schools (Fraenkel et al., 2012). Sadly, there are no straightforward rules regarding the number of respondents that could be lost before the representation of the population is genuinely impeded (Fraenkel et al., 2012). A researcher is advised that if he loses ten per cent of the initially chosen sample, he is encouraged to mention this limit and qualify his conclusion appropriately (Fraenkel et al., 2012). The primary time a researcher is not keen on generalising past the bounds of specific research is the point at which the results of a study are of interest just as used to a particular group of individuals at a particular time and where every one of the individuals from the population is respondents in the research (Fraenkel et al., 2012). Therefore, the current study's results are not generalised beyond the studied population. In South Africa, the whole population was part of the sample, as the IBDP schools were too few. In Singapore, the current study results apply only to the population being studied, the IBDP schools in Singapore. The current study population is IBDP 2 learners doing the IBDP Mathematics AA course for examinations in 2022 in South Africa and Singapore. The results of the present research are also ecologically generalizable. Ecological generalizability alludes to how much the research results can be reached in different conditions or settings (Fraenkel et al., 2012). The settings should be similar in exceptionally significant regard in any new circumstance where researchers wish to attest that their discoveries apply (Fraenkel et al., 2012). Therefore, the current study results

could also be generalised to other settings similar to that of Singapore and South Africa in which the current study was conducted.

Procedures employed in data collection

This study received approval from the Unicaf UREC committee before data collection (see Appendix B). To obtain permission to collect data in Gauteng and Western Cape provinces in South Africa, an application letter, the current study proposal, the consent forms, and the data collection tool were sent to the Gauteng Department of Education and the Western Cape Department of Education. In addition, authorisation letters were generated by each department of Education, authorising the data collection process (see Appendix D and Appendix F). To obtain permission to collect data in Singapore, the researcher sent an application letter, the current study proposal, the consent forms, and the data collection tool to the Research Department of the Singapore Ministry of Education. In addition, the researcher obtained an authorising email from the Ministry of Education (see Appendix H).

To further obtain permission to collect data from the IBDP schools in South Africa and Singapore, the researcher sent to all principals the principal letter, gatekeeper letter, consent forms, and authorisation letters from the Gauteng Department of Education (for Gauteng schools), Western Cape Department of Education (for Western Cape schools), and Singapore Ministry of Education (for Singaporean schools), requesting to collect data in their schools. A list of learners from the South African schools who agreed to participate was sent to the researcher. Lists of learners were obtained from Singaporean schools for further sampling to come up with 50 learners doing the IBDP Mathematics AA Higher

Level course and 50 learners doing the IBDP Mathematics AA Standard Level course. Learners who signed their consent and assent forms were forwarded to the researcher for the data to be collected. The online data collection tool link was emailed to all participants to start submitting their responses to the survey questions. Appendix P shows data obtained from the rehearsal study.

Data analysis techniques

The current research uses statistical techniques to analyse the data. In correlational research, the initial step in analysing data is to create frequency polygons (Fraenkel et al., 2012). If the variables involved are quantitative, standard deviations and means are commonly computed (Apuke, 2017; Fraenkel et al., 2012). The inferential statistical data analysis methods employed in the current study are the t-test for independent means and confidence intervals for quantitative data. The t-test for contrasts between means is the most frequently utilised test (Apuke, 2017; Fraenkel et al., 2012).

The t-test for independent means

A t-test is a statistics test utilised for a two-mean comparison of two groups (Kim, 2015). The scholars add that nonparametric and parametric methods are the two kinds of statistical inferences widely used in research. A parametric method alludes to a statistical method where one characterises the distribution of probability variables' probabilities and makes an inference about the distribution parameters (Kim, 2015). The nonparametric method is utilised when the distribution of the probabilities cannot be defined, clarifies the scholar. The t-test is a parametric technique that could be utilised when the samples fulfil the states of independence, equal variance, and normality (Kim,

2015). The two t-tests used in statistics are the paired t-test and the independent t-test. The paired t-test is utilised when the two groups under examination depend on one another (Kim, 2015). The independent t-test is used when the two groups being compared are independent (Kim, 2015).

The t-test is otherwise called the Student's t-test. This statistical analysis procedure was established in 1908 by William Sealy Gosset to control the nature of dark brews (Kim, 2015). If the t-test is utilised to test the distinction between two independent sample means and finds no distinction between the two sample means, the distinction will be near nothing (zero). When the distinction is close to zero, additional statistics tests should be implemented to check whether the distinction could be alleged to be equivalent to nothing (zero) (Kim, 2015). When satisfying the equal variance and normality conditions, the differences in the means of the mutually independent two groups could be obtained by contrasting them by utilising a Student's t-test (Kim, 2017).

Assuming that the two samples have an equivalent variance and show a normal distribution, the t-statistic is given by the following equation (Kim, 2015):

$$t = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{s_{(1+2)}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \sim t(n_1 + n_2 - 2)$$

Where the difference between the means of the population ($\mu_1 - \mu_2$) was presumed to be zero, hence (Kim, 2015):

$$t = \frac{\overline{X}_1 - \overline{X}_2}{s_{(1+2)}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

A pooled variance of the two samples was utilised because the population variance was obscure (Kim, 2015):

$$s^2_{(1+2)} = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$$

Be that as it may, if the variances of the population are not equivalent, the t-statistic of the t-test is expected to be (Kim, 2015):

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

Furthermore, the degree of freedom is determined by the Welch Satterthwaite equation (Kim, 2015).

Contingency coefficients and cross-break tables

A crossbreak table shows all possible arrangements or combinations of at least two variables that are categorical and depicts the relationships (if they exist) among the variables (Fraenkel et al., 2012). Whenever an interest is in relationships between two variables that are categorical, it is generally represented in crossbreak tables (at times known as contingency tables) (Fraenkel et al., 2012). A relationship index calculated from crossbreak tables is called the contingency coefficient (Fraenkel et al., 2012). Potential relationships between categorical variables can be investigated by utilising contingency coefficients and cross-break tables, even though predictions from cross-break tables are inaccurate (Fraenkel et al., 2012). Luckily, there are a couple of inquiries of interest in Education, including the current research, that include two categorical variables (Fraenkel et al., 2012).

All relationships in the data collected in the present study were analysed through a cross-break table, correlation, or a comparison of means. The significant benefit of descriptive statistics is that they allow researchers to depict the data in numerous scores with only a couple of indices, like the median and mean (Fraenkel et al., 2012). In addition, studies that utilise surveys, contingency coefficients, crossbreak tables, and the percentage of responses to items posed are provided.

Summary

The instrument used by the researcher to collect data is one questionnaire. The researcher took about two and a half months to collect data, which was gathered once in February and April 2022, in the learners' final year of their diploma programme study. To

determine whether the independent variable significantly impacts the dependent variable, the researcher used the independent sample t-test to analyse the data from the questionnaire. In addition, relationships between categorical variables were investigated by utilising contingency coefficients and cross-break tables. Finally, to increase the understanding of the results, in chapter four, tables and graphs were used to display the results of the data analyses.

CHAPTER 4: FINDINGS

Introduction

The purpose of this correlational method research design study was to find The difference in the availability of school-related resources to IBDP 2 learners in South Africa and Singapore; The difference in the accessibility of the school-related resources of IBDP 2 Learners in South Africa and Singapore; The difference in the school-related resources utilisation of IBDP 2 Learners in South Africa and Singapore; The difference in the Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore; Relationship between school-related resources availability and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore; Relationship between school-related resources accessibility and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore; Relationship between school-related resources utilisation and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore. The data collection period was from 01 February 2022 to 31 May 2022.

When analysing data in quantitative research, a researcher uses statistics and parameters. Parameters are characteristics of a population. They are graphic or numerical ways of summing up data from the population. On the other hand, statistics are characteristics of a sample. Therefore, they are graphical or numerical ways of summarising data obtained from the sample. Categorical and quantitative data are the two major numerical data types a researcher can collect in quantitative research.

Quantitative data are collected by determining position on a scale that shows degree or amount.

In contrast, categorical data are obtained by determining the recurrence of events in every one of a few categories. There are different kinds of scores used in quantitative research. Standard, percentile ranks, age or grade, and raw scores. Standard scores are numerically determined scores that have comparable meanings on various instruments. Percentile ranks are percentages of groups scoring under or at given raw scores. Age or grade equivalents are determined scores demonstrating the grade or age-related with a single raw score. Raw scores are the underlying scores obtained when utilising an instrument. In contrast, derived scores are raw scores converted into more valuable scores on some standardised premise to support interpretation (Fraenkel et al., 2012, 2022).

Techniques used to summarise quantitative data are frequency distribution, frequency polygon, graphical distribution, histogram, stem-leaf plot, normal distribution, distribution curve, and measures of central tendency. A frequency distribution is a high-to-low listing of a relative multitude of scores alongside their frequencies with two columns. A graphical presentation of frequency distribution is called a frequency polygon. It is a graphic way of summing up one variable in quantitative data**.** A histogram is a visual diagram showing ratio or quantitative interval data. A normal distribution is a symmetrical theoretical bell-shaped distribution in which many scores are amassed in the centre. The mode, median, and mean are equal in a normal distribution. The mean and the median are measures of central tendency utilised to summarise quantitative data. The standard

deviation is the most widely recognised measure of variation in educational research. The range is the difference between the largest and the lowest scores and is another measure of variation. A five-number summary of a distribution (least score, lower quartile, median, upper quartile, and largest scores) is frequently depicted graphically by utilising a box-whisker plot. Standard scores utilise a typical scale to demonstrate how one data compares to multiple data in a group. The z score is the easiest type of standard score.

A z score communicates, in standard deviation units, how far off a raw score is from the mean. The mathematical index communicating the level of relationship between two quantitative variables is called the correlation coefficient. Pearson R is one of the most usually utilised correlations in educational studies. A scatterplot is a graphical technique depicting a connection between two quantitative variables. A researcher utilises different graphical methods to summarise categorical data in research. These techniques are pie charts, bar graphs, and frequency tables. Crossbreak tables represent a relationship between at least two categorical variables (Fraenkel et al., 2012, 2022).

The discussion of research findings in Chapter 4 starts with an introduction that gives a brief overview of the purpose of the current research study and a brief overview of the organisation of the chapter. The introduction section was followed by the discussion of the trustworthiness of data section, which discussed ways to secure the data's trustworthiness. The following section was the reliability and validity of data discussion, followed by the results of findings, including the graphical illustrations section. Under the results of the findings section, the researcher discussed data analysis techniques and findings for school-related resources availability and Mathematics achievement,

accessibility and Mathematics achievement, school-related resources utilisation and Mathematics achievement, and Mathematics achievement of IBDP 2 learners in South Africa and Singapore. The next section was the evaluation of findings, followed by the summary of the chapter.

Validity and reliability of data

As a quantitative researcher, the techniques utilised to secure the current study's trustworthiness consist of objectivity, reliability, and external and internal validity. In quantitative research, objectivity is used by employing data analysis, data collection, and measurement methodologies to establish validity and reliability (Farrelly, 2013). The scholar adds that objectivity is carried out through systemic techniques like randomisation and instrumentation. In quantitative studies, the researcher focuses on factual information. Objectivity likewise alludes to the proper distance between participants and a researcher that diminishes unfairness (Farrelly, 2013). The scholar concludes that the objective of a researcher is far off with the goal of not being influenced by participants, which can impact the study. In the current research, objectivity was secured by distancing. Due to COVID-19 travel restrictions, the researcher could not reach or see any survey respondents. The COVID-19 travel restrictions maximised the objectiveness of the current study.

In quantitative research, reliability is used to lay out trustworthiness (Farrelly, 2013; Heale & Twycross, 2015). The scholars point out that a quantitative researcher uses reliability by looking at the consistency of a set of measuring instruments or measurements utilised in a study (otherwise called internal-consistency). A quantitative

researcher uses internal validity techniques to establish trustworthiness (Farrelly, 2013). A quantitative researcher assesses trustworthiness by evaluating the control measures of threats to internal validity and the study's measurements and instruments' validity (Heale & Twycross, 2015)(Heale & Twycross, 2015). The scholars say that if changes in the dependent variable occur from only the independent variable, as opposed to a confounding variable, then internal validity is supported. Subject impacts, experimenter impact, treatment diffusion, statistical regression, a subject wearing down, treatment replications, instrumentation, pretesting, maturation, selection, and history threaten internal validity (Farrelly, 2013; Heale & Twycross, 2015). A researcher uses the test-retest technique by administering one test to a group of respondents, waiting for a specific amount of time, then re-administer an exact test to the same group of respondents, then finding the relationship between the two sets of scores obtained (Farrelly, 2013; Heale & Twycross, 2015). The agreement is one more technique reliability is estimated by ratters noticing similar ways of behaving and inspecting whether they have comparative and predictable outcomes to each other, add the scholars. Reliability quality is critical to a quantitative researcher since it is a reason for legitimacy and measures whether research gets similar outcomes each time (Farrelly, 2013). To test reliability in the current study, the researcher tested the same variable more than once in different ways. Furthermore, Cronbach's Alpha reliability coefficient was computed to establish the level of reliability of each item in the research instrument.

A quantitative researcher uses the technique of external validity to lay out dependability or trustworthiness (Farrelly, 2013; Heale & Twycross, 2015). The

generalisability from the research sample to the bigger populace uses external validity. It is significant for a quantitative researcher to look at the sampling method to determine if a study is trustworthy, adds the scholars. A researcher uses external validity to offer sensible, accurate statements by computing statistical confidence limits (Farrelly, 2013; Heale & Twycross, 2015). Measures, intervention, time, situation, and subjects are factors a quantitative researcher should investigate because they could influence the external validity and generalisability of the results (Farrelly, 2013). The current study's researcher used stratified and systematic random sampling to secure external validity. The researcher further computed confident statistical values in PSPP (no official expansion of the acronym) statistical software to form sensible, accurate statements. However, there were threats of external validity that were observed in the situation and subjects. The COVID-19 situation posed a threat in the sense that the researcher was unable to talk to the subjects face-to-face. The researcher heavily relied on the administration of the institutions in carrying out the processes of the study throughout the data collection period.

Reliability and validity of data

Reliability data

Reliability alludes to the consistency of responses or scores obtained from an instrument and a set of items irrespective of the number of times a questionnaire is administered or the number of different groups of items administered by the researcher (Fraenkel et al., 2012). In addition, the instrument's reliability alludes to the uniformity of

the responses or scores acquired and the scores' consistency when the instrument and set of items are administered several times to the same individual (Fraenkel et al., 2012).

Since measurement mistakes are consistently present, a researcher anticipates differences in test scores when administering the same instrument to the same group at least twice (Fraenkel et al., 2012). Estimates of reliability give a researcher a clue of how much disparity to anticipate (Fraenkel et al., 2012). Such reliability estimates are typically communicated as one more utilisation of the relationship coefficient known as a reliability coefficient (Fraenkel et al., 2012). A reliability coefficient likewise conveys an association; however, it is between scores on two areas of the same questionnaire or the same questionnaire on two distinct occasions of the same persons (Fraenkel et al., 2012). The internal consistency, the equivalent forms, and the test-retest are the three most popular methods of acquiring a reliability coefficient (Fraenkel et al., 2012). The reliability coefficient range should be 0 to 1, without negative values (Fraenkel et al., 2012).

When two distinctive yet equivalent (likewise called parallel or alternate) types of a questionnaire are given to the same set of individuals during a similar time frame, it is called the equivalent-form method (Fraenkel et al., 2012). Although the items are unique, they should test a similar substance and be developed independently from one another (Fraenkel et al., 2012). The reliability coefficient is then determined between the two scores acquired (Fraenkel et al., 2012). A high-reliability coefficient would indicate solid proof of reliability (Fraenkel et al., 2012). Coefficients of reliability will be influenced by the time allotment that slips between the two administrations of the tests (Fraenkel et al., 2012). The more extended the time stretch, the lower the reliability coefficient since there

is a more substantial probability of changes in the people taking the survey (Fraenkel et al., 2012). Therefore, a reasonable period should be chosen to check for reliability proof of test-retest (Fraenkel et al., 2012). This span ought to be during which people would be expected to hold their overall position in a group (Fraenkel et al., 2012).

All the techniques referenced so far require double testing periods. However, a few internal-consistency methods for assessing reliability quality require just a solitary questionnaire administration (Fraenkel et al., 2012). For example, the split-half process could determine an instrument's internal consistency (Fraenkel et al., 2012). The split-half includes scoring two parts (typically even items versus odd items) of a questionnaire independently for every individual and then, at that point, computing a correlation coefficient for the two groups of scores (Fraenkel et al., 2012). The coefficient shows how much the two parts of the test give equivalent outcomes and consequently depicts the internal consistency of the questionnaire (Fraenkel et al., 2012). The reliability coefficient is determined using the Spearman-Brown prediction equation (Fraenkel et al., 2012).

$$\text{Reliability of scores on total test} = \frac{2 \times \text{reliability for } \frac{1}{2} \text{ test}}{1 + \text{reliability for } \frac{1}{2} \text{ test}}$$

(Fraenkel et al., 2012, p. 156)

The reliability of a questionnaire can be improved by adding more items if they are like the first ones (Fraenkel et al., 2012). The Kuder-Richardson approach may be the most utilised technique for determining internal consistency (Fraenkel et al., 2012). The Kuder-Richardson approach requires just three snippets of information: the standard deviation, the mean, and the number of items (Fraenkel et al., 2012).

$$\text{KR21 reliability coefficient} = \frac{K}{K-1}\left[1 - \frac{M(K-M)}{K(SD^2)}\right]$$

(Fraenkel et al., 2012, p. 156)

where K = number of items on the test, M = mean of the set of test scores, and SD = standard deviation of the set of test scores.†

A valuable guideline for research is that reliability should be at any rate of 0.70 and ideally higher (Fraenkel et al., 2012).

The current study questionnaire items were adapted from TIMSS Advanced 2015 global study context questionnaires (Mullis & Hooper, 2015b). The TIMSS Advanced International Study Context questionnaires were assessed after the field test to check the reliability and validity of the different scales of the questionnaires (Mullis & Hooper, 2015b). The reliabilities for the TIMSS Advance 2015 global study context questionnaires were generally high, with a worldwide median reliability coefficient of 0.88 (median value for all participating countries) in Mathematics (Mullis & Hooper, 2015b). The reliability coefficient is the median Cronbach's alpha reliability in all assessment instruments in TIMSS Advanced 2015 (Mullis & Hooper, 2015b).

The overall average reliability coefficient of the data for the current study is $0.8033333333 \approx 0.80$. It was 0.86 for the scale data, 0.59 for nominal data, and 0.96 for ordinal data. The reliability strength of the data varied according to the collected data type. The ordinal data showed a very high-reliability coefficient (0.96), followed by scale data with a high-reliability coefficient (0.86), while the reliability coefficient of the nominal data was a bit low (0.59). The data collected in the current study was reliable (0.80). However, the reliability coefficient of the nominal data (0.59) raises reliability concerns

about the data collected in the current study, even though it was not significantly low (below 0.5).

Validity of data

The absence of randomisation and powerlessness to manipulate the independent variable are two shortcomings in correlational studies (Fraenkel et al., 2012). Internal validity's major threat to correlational research is the likelihood of selection bias (Fraenkel et al., 2012). The central systems a researcher can utilise to lessen this danger include matching research participants on a related variable, making homogeneous smaller groups, and utilising statistical matching. Internal validity threats in correlational research include losing subjects, instrumentation, and location (Fraenkel et al., 2012). Moreover, type 3 explorations depend upon execution, testing threats, regression, the attitude of subjects, history, and implementation (Fraenkel et al., 2012).

The observed validity threats of the data collected in the current study were the location and instrumentation. Due to COVID-19 worldwide restrictions on travelling, including a travel ban, the researcher could not go in person to the study subjects' location to allow the subjects to talk to the researcher and discuss the data collection procedure with all involved parties. Telephone calls and emails proved not to be the best way of communication. It was often difficult to talk to heads of schools and IBDP Coordinators as all calls go through secretaries first, and they usually took the message to pass on to the relevant officers. At the same time, the researcher waited for responses for weeks. Emails were sent to heads of schools several times, and they often could not get any answer. Finally, secretaries of the heads of schools requested the researcher to send all

relevant documents to them (consent forms, ascent forms, research questionnaires, and the link for accessing the online learner questionnaire). They promised to pass them on to relevant administrators and departments. The employed procedures were not intended to run and administer the respondents' questionnaires. However, the researcher did get responses from respondents through the online survey.

The quality of the instrument utilised in research is vital for the researcher's conclusion on the data they acquire (Fraenkel et al., 2012). Appropriately, a researcher uses various methodologies to guarantee that the researcher's inferences are reliable and valid in light of the data gathered (Fraenkel et al., 2012). The validity of an instrument alludes to the suitability, weightiness, accuracy, and value of the researcher's inferences (Fraenkel et al., 2012). On the other hand, the reliability of an instrument alludes to the uniformity of responses or scores obtained from a set of items in an instrument, irrespective of the number of times a questionnaire is administered or the number of different groups of items administered by the researcher (Fraenkel et al., 2012). The researcher knows that an instrument can be reliable, although not valid.

The significant part of validity as signs of adequate settings and conditions for learning was the positive relationship between TIMSS Advanced 2015 global context questionnaire scales and performance (Mullis & Hooper, 2015b). For the current study, Pearson correlation with IBDP Mathematics AA course achievement for South Africa and Singapore and R-squared, the ratio of variance in performance owing to the Learners Like Learning Mathematics scale was also used in the current study (Mullis & Hooper, 2015b). Using the Pearson correlation, R, at a significant level for the current research,

the researcher found p < 0.05 in at least 150 response items out of 178 in the survey. For $p < \alpha$ indicates that the response is valid. More than 84% of the responses collected in the current study were valid. For the remaining 16%, they were either inconclusive, not applicable or $p > \alpha$. The researcher concludes by stating that the responses collected were valid.

Results of findings, including graphical illustrations

Data analysis techniques

The data acquired from the survey were broken down using inferential statistics, descriptive statistics and PSPP (no official expansion of the acronym) software (Vakili & Pourrazavy, 2017). The tests utilised in the current research incorporate Pearson's correlation and Spearman's rank correlation. Practically all relationships in data can be studied through a crossbreak table, a correlation, or a comparison of means (Fraenkel et al., 2012, 2022). However, at the point when a researcher wants to see if there are huge contrasts between the means for multiple groups, they usually utilise a strategy called analysis of variance (ANOVA), which is a more common type of t-test that is fitting to use with at least two or more groups (Fraenkel et al., 2012, 2022).

To determine whether a correlation coefficient calculated on sample data is significant, the t-test for R is utilised. The t-test determines whether the correlation coefficient addresses a non-zero relationship in the populace from which the sample was taken. It is like the t-test for means, except here, the statistics being worked with is a correlation coefficient (R) as opposed to a contrast between means. The test creates a value for t (called obtained t) that a researcher checks in a statistics table to determine if

it is significant statistically. The bigger the obtained value for t, similar to other parametric tests, the greater the probability that significance has been accomplished (Fraenkel et al., 2012, 2022).

Results of findings

In total, 169 learners participated in the current study, where 80 were from Singapore and 89 were from South Africa. Unfortunately, one school was pulled out of the study in South Africa for personal reasons.

Relationship between school-related resource availability and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore.

The first research question for the current study was: What is the relationship between school-related resource availability and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore? Twelve items in the survey were used to measure the relationship between school-related resource availability and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore. The reliability coefficients (Cronbach's Alpha) were 0.43 and 0.57 for the data collected in South Africa and Singapore, respectively (see Appendix R). At the same time, the reliability coefficient Omega was inconclusive for South Africa and 0.76 for Singapore (*see Table* 4). The reliability coefficient (Cronbach's Alpha) for the data from the two countries combined was 0.78, while the reliability coefficient Omega was 0.79. Therefore, we can conclusively say that the data were reliable, even though the reliability was not strong. The Spearman's

rank correlation was R = 0.60 for South Africa (see *Table 3*) and R = 0.45 for Singapore (see *Table 4*).

Indeed, the debate on whether the informational worth of point estimations is negligible contrasted with the worth of confidence interval has existed for a long time (Ayanwale, Alasa & Ayeniran, 2022). According to Ayanwale and colleagues (2022), it is imperative to express that SPSS misses the mark on the ability to produce confidence intervals for the vast majority of its statistics. Hence, the current researcher used Cronbach's Alpha and McDonald's Omega to compute reliability coefficients for the collected data. Coefficient Omega estimates reliability coefficients for a non-mental instrument contrasted with Cronbach Alpha and gives bit-by-bit approaches to computing estimates. The reliability coefficient Omega's computation depends on the polychoric relationship lattice of the data (Ayanwale et al., 2022). The reliability coefficient Omega's computation depends on the polychoric relationship lattice of the data.

Table 4

The Relationship Between School-Related Resources Availability and Mathematics Achievement of IBDP 2 Learners in South Africa

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.60	0.37	0.27	0.83

Table 5

The Relationship Between School-Related Resources Availability and Mathematics Achievement of IBDP 2 Learners in Singapore

R	R Square	Adjusted R Square	Std. Error of the Estimate	Reliability McDonald's Omega
0.45	0.21	0.06	0.43	0.76

The relationship was significant for South Africa ($p = 0.000 < \alpha = 0.05$) (see *Table 5*) and insignificant for Singapore ($p = 0.166 > \alpha = 0.05$) (see *Table 6*).

Table 6

ANOVA for the Relationship Between School-Related Resources Availability and Mathematics Achievement of IBDP 2 Learners in South Africa

	Sum of Squares	df	Mean Square	F	Sig.
Regression	29.97	12	2.50	3.66	0.000
Residual	51.92	76	0.68		
Total	81.89	88			

Table 7

ANOVA for the Relationship Between School-Related Resources Availability and Mathematics Achievement of IBDP 2 Learners in Singapore

	Sum of Squares	df	Mean Square	F	Sig.
Regression	3.29	12	0.27	1.45	0.166
Residual	12.66	67	0.19		
Total	15.95	79			

The statistics indicated a relationship between school-related resource availability and Mathematics Achievement of IBDP 2 Learners in South Africa. However, no relationship existed between school-related resource availability and the Mathematics Achievement of IBDP 2 Learners in Singapore.

Table 8

Unstandardized Predicted Value for Availability of School-Related Resources for South Africa

ID	Unstandardized value	Math Grade	ID	Unstandardized value	Math Grade	ID	Unstandardised value	Math Grade
1	6.7	7	38	4.8	5	75	5.5	6
2	6.0	4	39	5.4	6	76	5.9	6
3	6.5	6	40	5.8	6	77	5.2	4
4	6.3	7	41	5.9	5	78	5.4	6
5	6.1	6	42	5.9	5	79	5.5	7
6	6.1	6	43	5.8	5	80	5.7	5
7	6.6	7	44	6.1	7	81	5.6	5
8	6.5	7	45	5.0	4	82	3.9	3
9	6.3	7	46	6.3	6	83	5.5	6
10	6.5	6	47	5.7	7	84	4.8	5
11	6.2	7	48	6.2	6	85	4.1	5
12	4.5	5	49	5.6	6	86	4.2	4
13	5.6	6	50	5.9	6	87	4.1	5
14	6.2	7	51	6.3	6	88	4.5	6
15	6.2	6	52	5.8	5	89	4.3	4
16	6.1	5	53	5.6	6			
17	6.0	6	54	6.2	7			
18	5.7	6	55	5.6	5			
19	6.0	6	56	5.8	5			
20	5.6	4	57	5.6	6			
21	5.9	7	58	5.5	4			
22	5.9	6	59	5.6	6			
23	6.0	5	60	5.2	5			
24	6.2	5	61	5.7	6			
25	6.0	6	62	5.8	5			
26	5.7	6	63	5.3	3			
27	5.6	6	64	6.3	7			
28	6.2	6	65	6.3	6			
29	6.0	7	66	6.1	7			
30	5.2	5	67	5.8	6			
31	5.6	5	68	5.4	6			
32	5.2	5	69	5.5	5			
33	5.4	6	70	5.1	5			
34	6.1	7	71	5.4	6			
35	5.4	5	72	5.8	7			
36	4.9	4	73	5.7	6			
37	5.5	6	74	5.7	5			

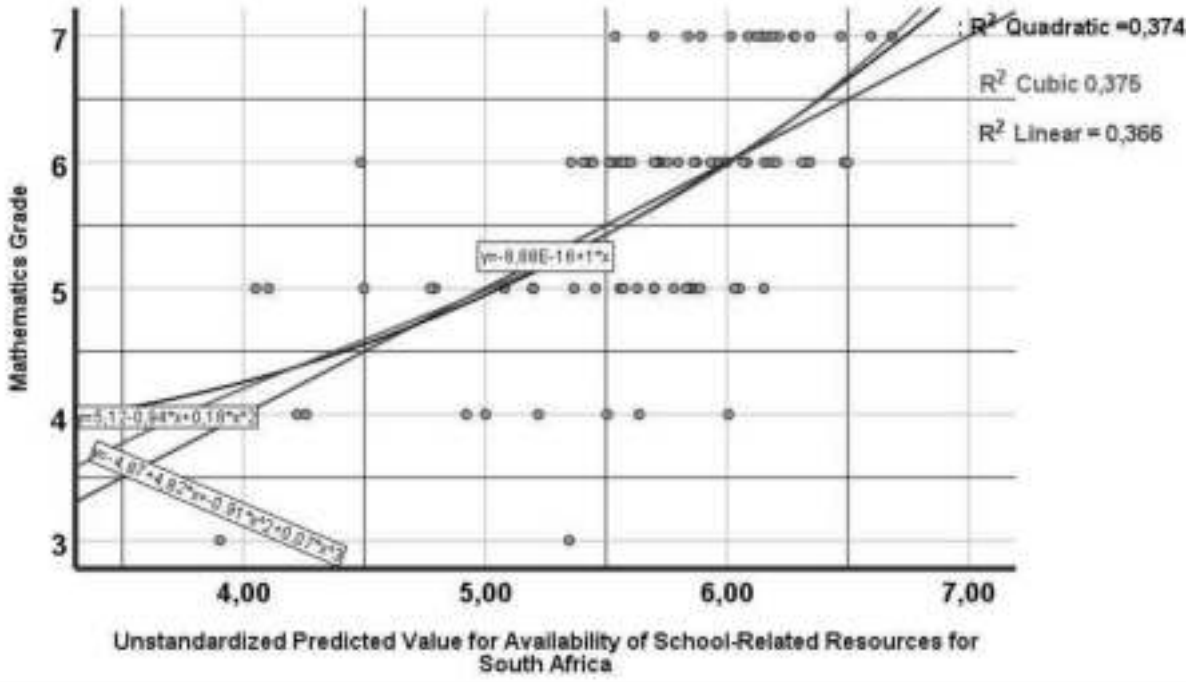

***Figure 8*.** Linear, quadratic, and cubic regression models for the relationship between availability of school-related resources and Mathematics achievement in South Africa

Figure 8 demonstrates three regression models (linear, quadratic, and cubic) of the relationship between the availability of school-related resources and the Mathematics achievement of IBDP learners in South Africa. The coefficients of determination (R^2) were 36.6% (linear regression model), 37.4% (quadratic regression model), and 37.5% (cubic regression model) (see *Figure 8*). The coefficient of determination is the most informative proportion of variance between the independent and dependent variables (Chicco, Warrens & Jurman, 2021; Fraenkel et al., 2012). For the current study, the coefficients of determination scores indicated that the independent variable (availability of school-related resources) accounted for only 36.6% or 37.4% or 37.5% of the dependent variable

(Mathematics achievement). All three regression models indicated that the independent variable accounted for a small proportion of the independent variable (between 36.6% and 37.5%).

Table 9

Unstandardised Predicted Value for Availability of School-Related Resources for Singapore

ID	Unstandardised value	Math Grade	ID	Unstandardised value	Math Grade	ID	Unstandardised value	Math Grade
1	6.6	7	38	6.6	7	75	6.9	7
2	7.1	6	39	6.6	7	76	6.9	7
3	7.0	7	40	6.8	7	77	6.9	7
4	7.1	7	41	7.1	7	78	6.6	6
5	6.5	7	42	6.9	7	79	7.0	7
6	6.7	7	43	6.9	7	80	6.5	7
7	6.9	7	44	6.7	7			
8	6.4	6	45	6.4	7			
9	7.0	7	46	6.7	6			
10	6.9	7	47	7.0	7			
11	6.8	7	48	6.8	7			
12	6.6	7	49	6.9	7			
13	6.8	7	50	6.9	7			
14	6.8	6	51	6.7	7			
15	6.8	7	52	7.0	7			
16	6.5	7	53	6.8	6			
17	6.9	7	54	6.6	6			
18	6.7	6	55	7.0	7			
19	6.8	7	56	6.8	7			
20	6.7	7	57	6.7	6			
21	6.8	7	58	6.8	6			
22	6.8	7	59	6.7	7			
23	6.8	7	60	6.8	7			
24	6.7	6	61	6.9	7			
25	7.0	7	62	6.9	7			
26	6.8	7	63	6.9	7			
27	6.8	7	64	6.9	7			
28	7.2	7	65	6.7	7			
29	6.9	7	66	7.0	7			
30	6.9	7	67	7.0	7			
31	6.8	7	68	6.6	7			
32	7.0	7	69	6.3	6			
33	6.8	6	70	6.7	7			
34	6.9	7	71	6.3	7			
35	6.5	6	72	6.7	7			
36	6.2	5	73	6.4	6			

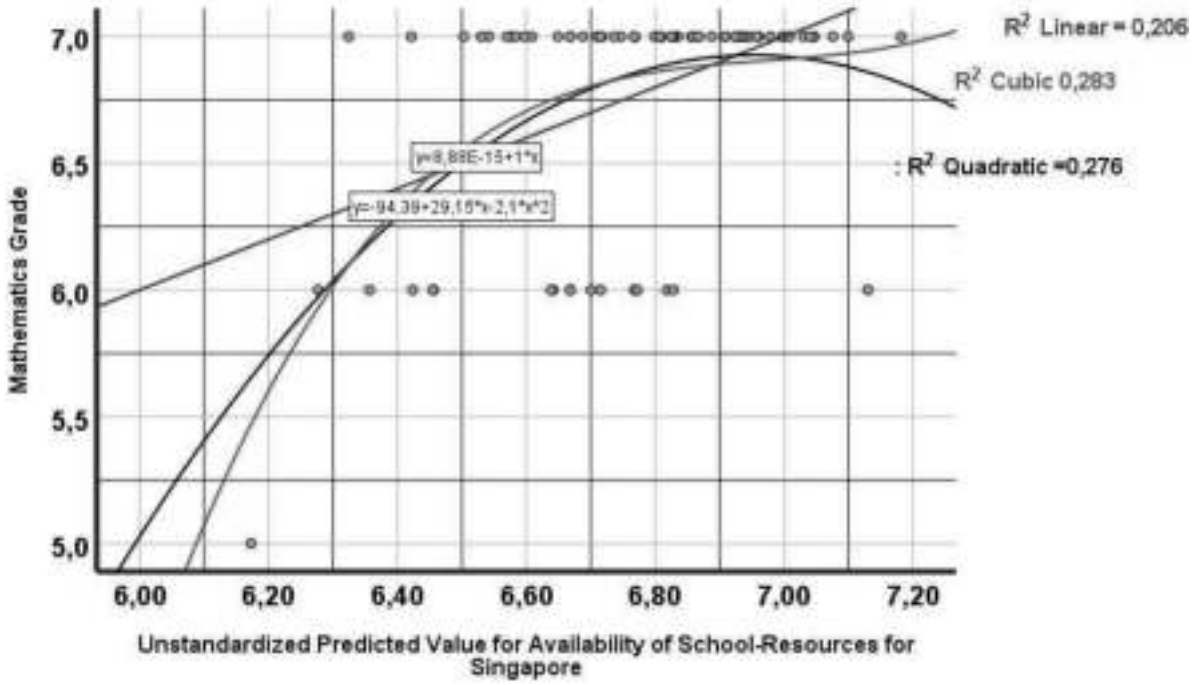

Figure 9. Linear, quadratic, and cubic regression models for the relationship between the availability of school-related resources and Mathematics achievement in Singapore

Figure 9 demonstrates three regression models (linear, quadratic, and cubic) of the relationship between the availability of school-related resources and the Mathematics achievement of IBDP learners in Singapore. The coefficients of determination (R^2) were 20.6% (linear regression model), 27.6% (quadratic regression model), and 28.3% (cubic regression model) (see *Figure 9*). For the current study, the coefficients of determination scores indicated that the independent variable (availability of school-related resources) accounted for only 20.6% or 27.6% or 28.3% of the dependent variable (Mathematics achievement). All three regression models indicated that the independent variable

accounted for a small proportion of the independent variable (between 20.6% and 28.3%).

Relationship between school-related resource accessibility and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore.

The second research question for the study was: What is the relationship between school-related resource accessibility and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore? The ten items in the survey collected data to measure the relationship between school-related resource accessibility and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore. The reliability coefficient (Cronbach's Alpha) was 0.97 and 0.85 for the data collected in South Africa and Singapore, respectively (see Appendix R). On the other hand, the reliability coefficient Omega was 0.98 and 0.82 for South Africa and Singapore, respectively (*see Tables 9 and 10*). The reliability coefficient (Cronbach's Alpha) for the two countries combined was 0.97 (see Appendix R). The reliability coefficient Omega was also 0.97 for the combined countries. Therefore, the reliability coefficient indicated that the data collected by the ten items were reliable. The Spearman's rank correlation was R = 0.58 for each of the two countries, South Africa and Singapore (see *Tables 9* and *10*).

Table 10

The Relationship Between School-Related Resources Accessibility and Mathematics Achievement of IBDP 2 Learners in South Africa

R	R Square	Adjusted R Square	Std. Error of the Estimate	Reliability Coefficient McDonald's Omega
0.58	0.33	0.25	0.84	0.98

Table 11

The Relationship Between School-Related Resources Accessibility and Mathematics Achievement of IBDP 2 Learners in Singapore

R	R Square	Adjusted R Square	Std. Error of the Estimate	Reliability Coefficient McDonald's Omega
0.58	0.34	0.25	0.39	0.82

The correlation was significant in both countries, $p = 0.000 < \alpha = 0.05$ for South Africa with F = 3.91 (see *Table 11*), and $p = 0.001 < \alpha = 0.05$ for Singapore with F = 3.58 (see *Table 12*).

Table 12

ANOVA for The Relationship Between School-related Resources Accessibility and Mathematics Achievement of IBDP 2 Learners in South Africa

	Sum of Squares	df	Mean Square	F	Sig.
Regression	27.35	10	2.74	3.91	0.000
Residual	54.53	78	0.70		
Total	81.89	88			

Table 13

ANOVA for The Relationship Between School-Related Resources Accessibility and Mathematics Achievement of IBDP 2 Learners in Singapore

	Sum of Squares	df	Mean Square	F	Sig.
Regression	5.45	10	0.54	3.58	0.001
Residual	10.50	69	0.15		
Total	15.95	79			

The statistics indicated a positive relationship between school-related resource accessibility and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore.

Table 14

Unstandardised Predicted Value for Accessibility of School-Related Resources for South Africa

ID	Unstandardised value	Math Grade	ID	Unstandardised value	Math Grade	ID	Unstandardised value	Math Grade
1	5.8	7	38	5.8	5	75	5.5	6
2	6.6	4	39	5.8	6	76	5.0	6
3	5.8	6	40	5.5	6	77	5.0	4
4	6.4	7	41	5.8	5	78	5.8	6
5	6.4	6	42	5.8	5	79	5.2	7
6	6.4	6	43	5.8	5	80	5.0	5
7	6.4	7	44	6.1	7	81	5.0	5
8	6.6	7	45	5.0	4	82	4.5	3
9	5.8	7	46	5.8	6	83	5.0	6
10	6.6	6	47	5.8	7	84	4.7	5
11	6.2	7	48	6.1	6	85	4.0	5
12	5.5	5	49	6.1	6	86	4.0	4
13	6.1	6	50	5.8	6	87	4.2	5
14	5.8	7	51	5.8	6	88	5.2	6
15	6.1	6	52	5.0	5	89	4.9	4
16	6.1	5	53	5.8	6			
17	6.1	6	54	6.1	7			
18	6.2	6	55	5.8	5			
19	5.8	6	56	5.1	5			
20	5.8	4	57	5.5	6			
21	5.9	7	58	4.9	4			
22	5.9	6	59	5.8	6			
23	5.9	5	60	5.3	5			
24	5.5	5	61	5.4	6			
25	5.9	6	62	5.5	5			
26	5.7	6	63	5.0	3			
27	5.8	6	64	6.5	7			
28	5.8	6	65	6.4	6			
29	5.8	7	66	6.6	7			
30	5.8	5	67	5.6	6			
31	5.7	5	68	6.2	6			
32	5.8	5	69	5.3	5			
33	5.9	6	70	5.0	5			
34	5.8	7	71	5.3	6			
35	5.6	5	72	6.2	7			
36	5.1	4	73	6.4	6			
37	5.8	6	74	5.0	5			

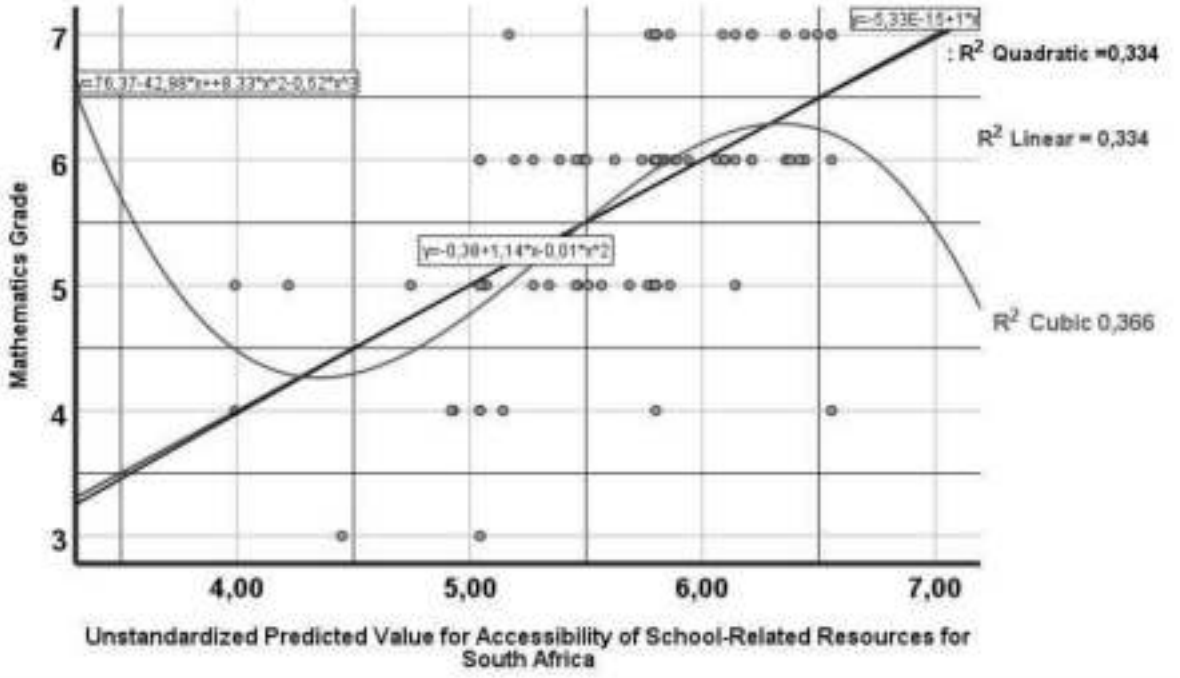

Figure 10. Linear, quadratic, and cubic regression models for the relationship between accessibility of school-related resources and Mathematics achievement in South Africa

Figure 10 demonstrates three regression models (linear, quadratic, and cubic) of the relationship between the accessibility of school-related resources and the Mathematics achievement of IBDP learners in South Africa. The coefficients of determination (R^2) were 33.4% (linear regression model), 33.4% (quadratic regression model), and 36.6% (cubic regression model) (see *Figure 10*). For the current study, the coefficients of determination scores indicated that the independent variable (accessibility of school-related resources) accounted for only 33.4% or 33.4% or 36.6% of the dependent variable (Mathematics achievement). All three regression models indicated that the independent variable accounted for a small proportion of the independent variable (between 33.4% and 36.6%).

Table 15

Unstandardised Predicted Value For Accessibility of School-Related Resources for Singapore

ID	Unstandardised value	Math Grade	ID	Unstandardised value	Math Grade	ID	Unstandardised value	Math Grade
1	6.8	7	38	6.9	7	75	6.6	7
2	6.8	6	39	6.9	7	76	6.9	7
3	6.8	7	40	6.7	7	77	6.2	7
4	6.8	7	41	6.9	7	78	6.4	6
5	6.8	7	42	6.7	7	79	6.9	7
6	6.8	7	43	6.9	7	80	6.6	7
7	7.1	7	44	6.8	7			
8	6.4	6	45	7.1	7			
9	6.8	7	46	6.1	6			
10	7.3	7	47	6.8	7			
11	6.9	7	48	6.8	7			
12	6.9	7	49	6.8	7			
13	6.7	7	50	6.8	7			
14	6.9	6	51	6.8	7			
15	6.9	7	52	6.8	7			
16	6.9	7	53	6.8	6			
17	7.1	7	54	6.8	6			
18	6.3	6	55	6.8	7			
19	6.5	7	56	6.8	7			
20	6.3	7	57	6.8	6			
21	7.1	7	58	6.8	6			
22	6.8	7	59	7.0	7			
23	7.1	7	60	6.8	7			
24	6.4	6	61	6.8	7			
25	7.1	7	62	7.0	7			
26	7.0	7	63	6.8	7			
27	6.9	7	64	6.9	7			
28	6.6	7	65	6.8	7			
29	7.0	7	66	6.8	7			
30	6.6	7	67	7.1	7			
31	6.9	7	68	6.8	7			
32	7.0	7	69	6.6	6			
33	6.4	6	70	6.8	7			
34	6.8	7	71	6.4	7			
35	6.1	6	72	6.9	7			
36	6.0	5	73	6.6	6			
37	6.9	7	74	6.2	6			

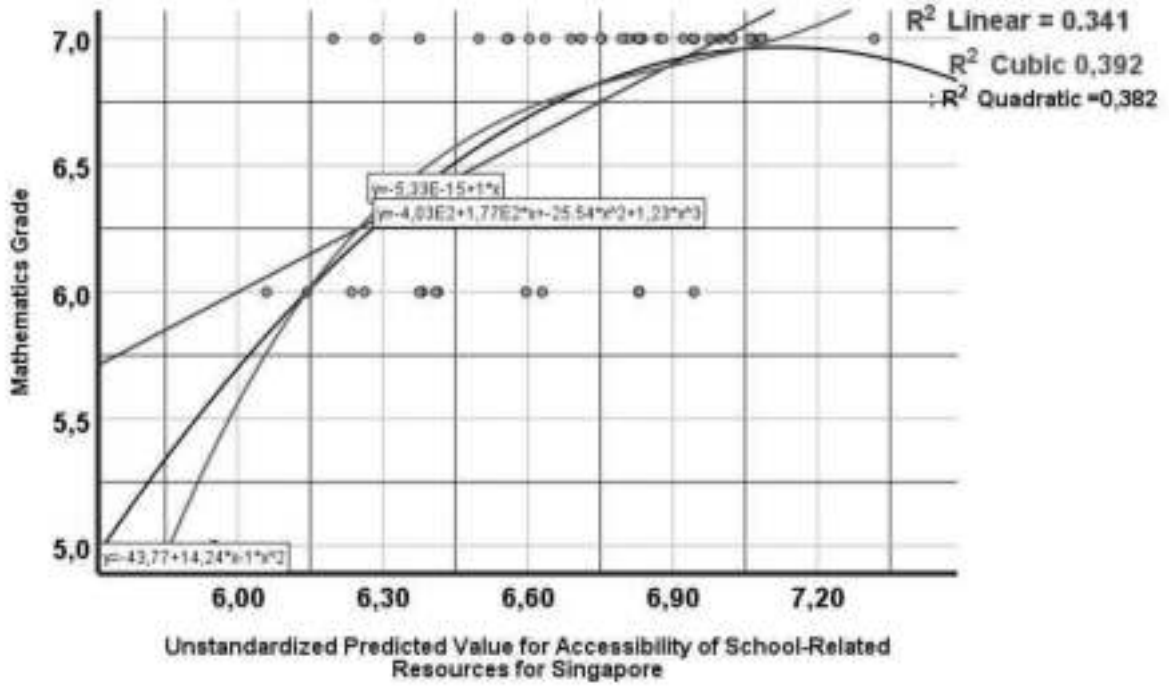

Figure 11. Linear, quadratic, and cubic regression models for the relationship between accessibility of school-related resources and Mathematics achievement in Singapore

Figure 11 demonstrates three regression models (linear, quadratic, and cubic) of the relationship between the accessibility of school-related resources and the Mathematics achievement of IBDP learners in Singapore. The coefficients of determination (R^2) were 34.1% (linear regression model), 38.2% (quadratic regression model), and 39.2% (cubic regression model) (see *Figure 11*). For the current study, the coefficients of determination scores indicated that the independent variable (accessibility of school-related resources) accounted for only 34.1% or 38.2% or 39.2% of the dependent variable (Mathematics achievement). All three regression models indicated

that the independent variable accounted for a small proportion of the independent variable (between 34.1% and 39.2%).

Relationship between school-related resource utilisation and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore.

The third research question was: What is the relationship between school-related resource utilisation and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore? Seventeen survey items measured the relationship between school-related resource utilisation and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore. The reliability coefficient (Cronbach's Alpha) was 0.97 and 0.89 for South Africa and Singapore, respectively (see Appendix R). The reliability coefficient Omega was 0.97 and 0.93 for South Africa and Singapore, respectively (see *Tables 15* and *16*). The reliability coefficient (Cronbach's Alpha) for the data from the two countries combined was 0.97 (see Appendix R). The reliability coefficient Omega was 0.98 for the combined countries. The reliability coefficient was acceptable, indicating that the 17 research items collected reliable data. The Spearman's rank correlation was 0.65 and 0.55 (see *Tables 15* and *16*) for South Africa and Singapore, respectively.

Table 16

The Relationship Between School-Related Resources Utilisation and Mathematics Achievement of IBDP 2 Learners in South Africa

R	R Square	Adjusted R Square	Std. Error of the Estimate	Reliability Coefficient MacDonald's Omega
0.65	0.43	0.29	0.81	0.97

Table 17

The Relationship Between School-Related Resources Utilisation and Mathematics Achievement of IBDP 2 Learners in Singapore

R	R Square	Adjusted R Square	Std. Error of the Estimate	Reliability Coefficient MacDonald's Omega
0.55	0.31	0.12	0.42	0.93

The correlation was significant for South Africa (F = 3.08, $p = 0.000 < \alpha = 0.05$) (see *Table 17*) and insignificant for Singapore (F = 1.62, $p = 0.087 > \alpha = 0.05$) (see *Table 18*).

Table 18

ANOVA for the Relationship Between School-Related Resources Utilisation and Mathematics Achievement of IBDP 2 Learners in South Africa

	Sum of Squares	df	Mean Square	F	Sig.
Regression	34.27	17	2.02	3.08	0.000
Residual	45.81	70	0.65		
Total	80.08	87			

Table 19

ANOVA for the Relationship Between School-Related Resources Utilisation and Mathematics Achievement Of IBDP 2 Learners in Singapore

	Sum of Squares	df	Mean Square	F	Sig.
Regression	4.90	17	0.29	1.62	0.087
Residual	11.05	62	0.18		
Total	15.95	79			

The statistics indicated a relationship between school-related resource utilisation and Mathematics Achievement of IBDP 2 Learners in South Africa. However, no relationship existed between school-related resource utilisation and Mathematics Achievement of IBDP 2 Learners in Singapore.

Table 20

Unstandardised Predicted Value for Utilisation of School-Related Resources for South Africa

ID	Unstandardized value	Math Grade	ID	Unstandardized value	Math Grade	ID	Unstandardized value	Math Grade
1	6.6	7	38	5.7	5	75	5.4	6
2	4.3	4	39	6.3	6	76	5.4	6
3	5.7	6	40	5.7	6	77	5.4	4
4	6.2	7	41	5.7	5	78	5.5	6
5	6.4	6	42	5.7	5	79	5.4	7
6	5.8	6	43	5.7	5	80	5.4	5
7	7.0	7	44	5.7	7	81	5.0	5
8	7.2	7	45	4.8	4	82	3.9	3
9	6.3	7	46	5.7	6	83	5.4	6
10	6.0	6	47	6.7	7	84	5.0	5
11	6.2	7	48	5.8	6	85	3.7	5
12	4.8	5	49	6.2	6	86	4.5	4
13	6.0	6	50	5.7	6	87	4.1	5
14	6.3	7	51	5.7	6	88	5.3	6
15	6.0	6	52	4.8	5	89	5.1	4
16	6.0	5	53	5.7	6			
17	6.2	6	54	6.0	7			
18	6.4	6	55	6.6	5			
19	5.8	6	56	4.3	5			
20	6.0	4	57	6.2	6			
21	6.2	7	58	4.8	4			
22	5.9	6	59	5.6	6			
23	5.7	5	60	5.2	5			
24	5.7	5	61	5.8	6			
25	5.7	6	62	5.8	5			
26	5.7	6	63	5.1	3			
27	5.7	6	64	6.5	7			
28	5.7	6	65	6.0	6			
29		7	66	6.3	7			
30	5.4	5	67	5.5	6			
31	5.7	5	68	5.5	6			
32	5.7	5	69	5.4	5			
33	6.0	6	70	5.4	5			
34	5.8	7	71	5.2	6			
35	6.1	5	72	5.7	7			
36	5.2	4	73	6.0	6			
37	6.0	6	74	5.0	5			

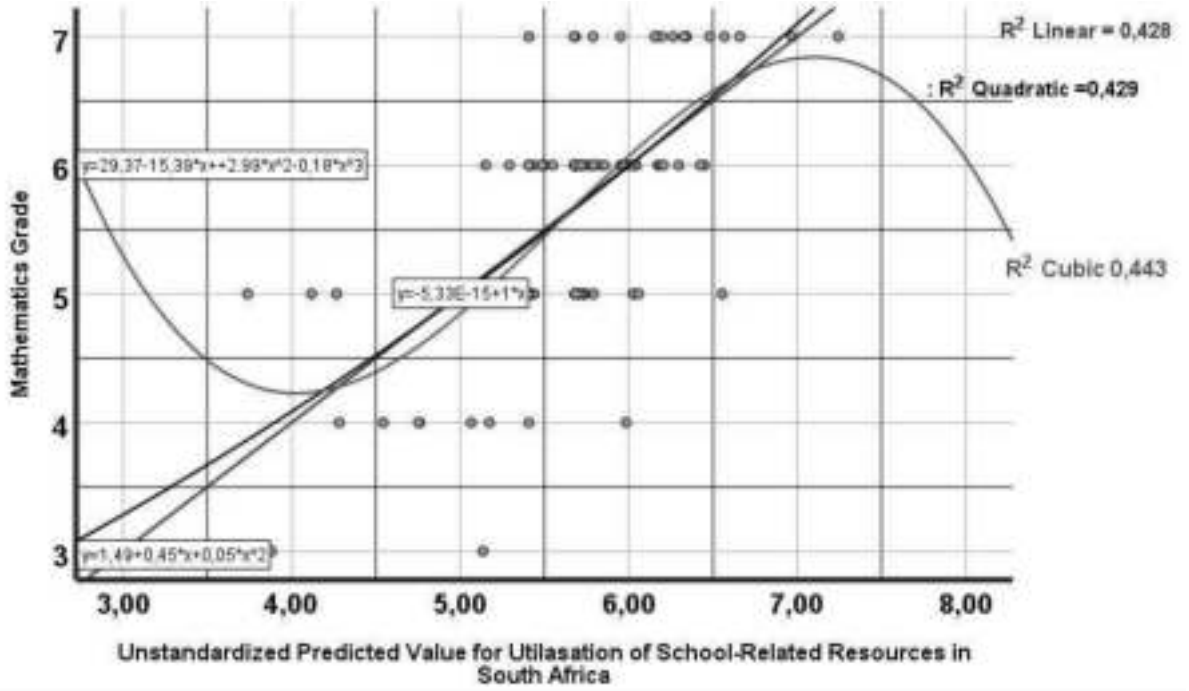

Figure 12. Linear, quadratic, and cubic regression models for the relationship between utilisation of school-related resources and Mathematics achievement in South Africa

Figure 12 demonstrates three regression models (linear, quadratic, and cubic) of the relationship between the utilisation of school-related resources and the Mathematics achievement of IBDP learners in South Africa. The coefficients of determination (R^2) were 42.8% (linear regression model), 42.9% (quadratic regression model), and 44.3% (cubic regression model) (see *Figure 12*). For the current study, the coefficients of determination scores indicated that the independent variable (utilisation of school-related resources) accounted for only 42.8% or 42.9% or 44.3% of the dependent variable (Mathematics achievement). All three regression models indicated that the independent variable

accounted for a moderate proportion of the independent variable (between 42.8% and 44.3%).

Table 21

Unstandardized Predicted Value for Utilisation of School-Related Resources for Singapore

ID	Unstandardized value	Math Grade	ID	Unstandardized value	Math Grade	ID	Unstandardized value	Math Grade
1	6.8	7	38	6.7	7	75	6.6	7
2	6.8	6	39	7.1	7	76	6.6	7
3	6.8	7	40	6.7	7	77	7.3	7
4	6.8	7	41	6.4	7	78	6.5	6
5	6.8	7	42	7.0	7	79	7.0	7
6	6.9	7	43	6.5	7	80	7.0	7
7	6.6	7	44	6.8	7			
8	6.7	6	45	7.2	7			
9	6.8	7	46	6.8	6			
10	6.7	7	47	6.8	7			
11	6.5	7	48	6.8	7			
12	7.2	7	49	6.7	7			
13	7.0	7	50	6.8	7			
14	6.7	6	51	6.9	7			
15	7.0	7	52	7.0	7			
16	7.0	7	53	6.4	6			
17	6.8	7	54	6.6	6			
18	6.8	6	55	6.6	7			
19	7.2	7	56	6.7	7			
20	6.7	7	57	6.7	6			
21	7.2	7	58	6.7	6			
22	6.8	7	59	6.9	7			
23	6.9	7	60	6.7	7			
24	6.4	6	61	6.6	7			
25	7.3	7	62	6.6	7			
26	6.8	7	63	6.6	7			
27	6.8	7	64	6.6	7			
28	6.7	7	65	6.7	7			
29	6.9	7	66	7.0	7			
30	7.1	7	67	7.2	7			
31	6.9	7	68	6.7	7			
32	7.4	7	69	6.7	6			
33	6.2	6	70	6.8	7			
34	6.6	7	71	6.5	7			
35	6.3	6	72	6.7	7			
36	5.9	5	73	6.4	6			
37	6.8	7	74	6.4	6			

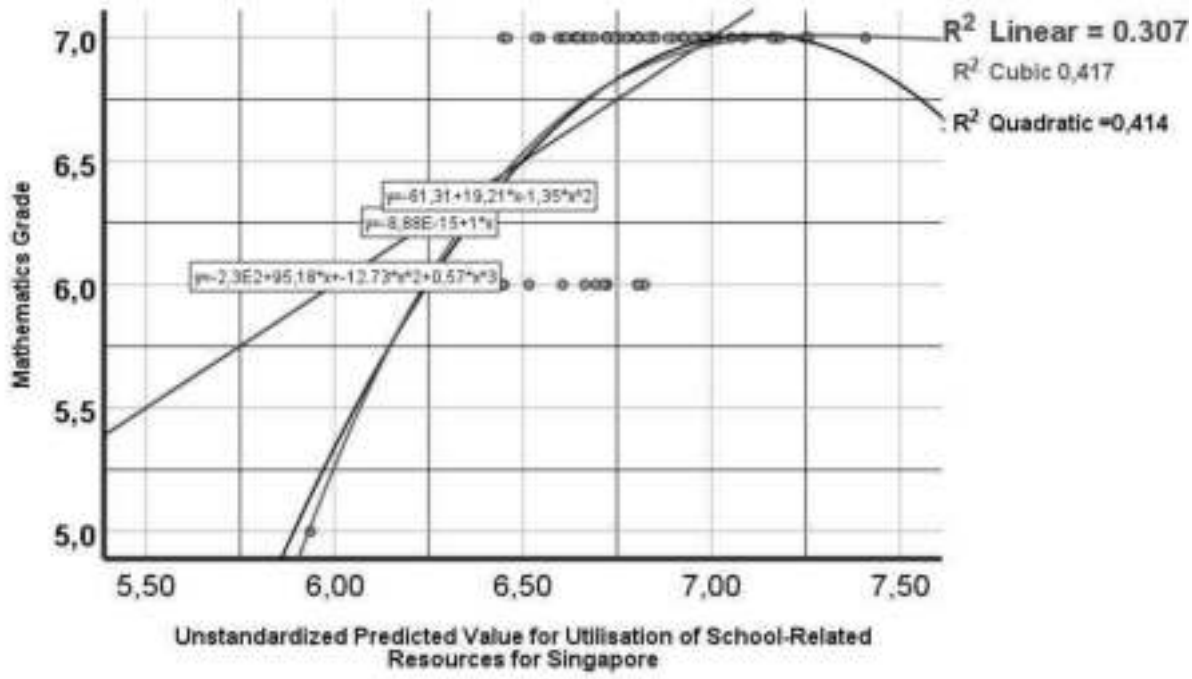

Figure 13. Linear, quadratic, and cubic regression models for the relationship between utilisation of school-related resources and Mathematics achievement in Singapore

Figure 13 demonstrates three regression models (linear, quadratic, and cubic) of the relationship between the utilisation of school-related resources and the Mathematics achievement of IBDP learners in Singapore. The coefficients of determination (R^2) were 30.7% (linear regression model), 41.4% (quadratic regression model), and 41.7% (cubic regression model) (see *Figure 13*). For the current study, the coefficients of determination scores indicated that the independent variable (utilisation of school-related resources) accounted for only 30.7% or 41.4% or 41.7% of the dependent variable (Mathematics achievement). Furthermore, only one of the three regression models indicated that the

independent variable accounted for a small proportion of the independent variable (30.7%). In contrast, the other two indicated a moderate proportion (41.4% and 41.7%).

Evaluation of findings

The current study comparatively investigated school-related resources as determinants of Mathematics achievement in IBDP learners doing Mathematics AA courses in South Africa and Singapore. This study used the Hierarchy of Needs theory of Abraham H. Maslow (*Figure 14*) and the Theory of Engagement of Greg Kearsley and Ben Shneiderman in developing the research framework.

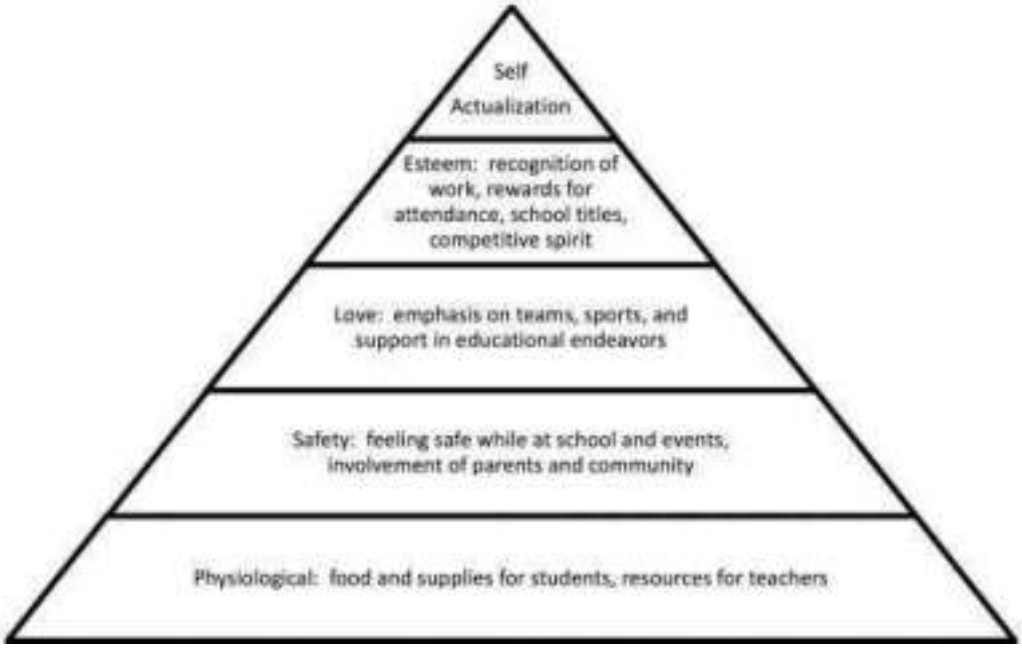

Figure 14*.* Needs Hierarchy of Maslow with teaching-learning support in Schools (B)
Notes: Needs Hierarchy of Maslow (Maslow, 1943, p. 372) about teaching-learning support in Schools (Fisher & Crawford, 2020, p. 13)

The current study is anchored and informed by Maslow's first stage of the needs hierarchy pyramid. The physiological needs explored with achievement in Mathematics are school-related resources. In addition, Kearsley's engagement theory of learning

states that every learner's activity includes dynamic mental processes, for example, interaction, creative thinking, evaluation, and decision-making (Kearsley & Shneiderman, 1998; Olagbaju & Popoola, 2020). The theory gives a solid framework to the current research exploring possibilities of good academic performance through the availability, accessibility, and utilisation of school-related resources through schoolroom collaboration, engagement, and participation.

The study's results reliably confirmed no significant difference in the availability of school-related resources for IBDP 2 Learners in South Africa and Singapore. Studies have stated that there is no statistical significance in the utilisation of teaching resources in Mathematics (Okoji & Olubayo, 2021), and a lack of Mathematics resources significantly impacted few learners (Elezovic, Lameva & Brese, 2022). Elezovic et al. (2022) further bolstered that the availability of school-related resources did not consistently significantly impact learner-achievement in Mathematics.

Although statistically unreliable, the results highlighted no significant difference in the accessibility of school-related resources for IBDP 2 Learners in South Africa and Singapore. Again, past studies have stated that the distribution of experienced educator resources was not significantly influenced by community or school size (P. S. Smith et al., 2013). Furthermore, as mentioned earlier, Okoji and Olubayo (2021) stated that there is no statistical significance in the accessibility of teaching resources in Mathematics.

Although not statistically reliable, the results showed no significant difference in the school-related resource utilisation of IBDP 2 Learners in South Africa and Singapore. The results could still be supported by Okoji & Olubayo (2021), who stated that there is

no statistical significance in the utilisation of teaching resources in Mathematics. Other studies also found that there were no detected negative impacts of the utilisation of PCs for the school teaching of Mathematics on learners' performance in Singapore, Norway, and Australia (Eickelmann et al., 2017).

Contrary to the above results, the achievement results confirmed a significant difference in the Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore. Studies indicated that in 39 countries that participated in TIMSS 2019 Mathematics studies in grade eight, South Africa obtained position 38, while Singapore was number one (Mullis et al., 2020; Graham, Mokgwathi, & de Villiers, 2021). Lindorff & Hall (2019) further bolstered the result, stating that to improve Mathematics achievement, initiatives for education in other countries, like the United Kingdom and the United States, have adopted Singapore-based strategies because of the high mathematics performance of Singaporean learners on international assessments. Since there is no significant difference in availability of school-related resources, accessibility and utilisation of IBDP 2 Learners in South Africa and Singapore, the difference in achievement might be because schools with the highest achievement rates typically had more learners from affluent backgrounds (Elezovic et al., 2022).

The results reliably indicated a relationship between school-related resource availability and Mathematics Achievement of IBDP 2 Learners in South Africa. Past studies observed that the quantity of school-related resources was connected with learners' Mathematics attainment in a study conducted in Croatia, Serbia, Macedonia and Albania (Elezovic et al., 2022). Other findings alluded that there was a significant

relationship between the effectiveness of the educational system and the availability of school-related resources (Esongo, 2017). However, the relationship's magnitude was judged to be low by the scholar.

However, the results reliably indicated no relationship between school-related resource availability and Mathematics Achievement of Singapore IBDP 2 learners. According to the international TIMSS 2019 results, higher Mathematics achievement on average was related to fewer resource shortages in schools and a greater emphasis on academic success (Mullis et al., 2020). The availability and upkeep of facility and learning resources were featured in Juta & Van Wyk's (2020) study as elements that both help or prevent the effectiveness of schoolroom management.

The results reliably indicated a positive relationship between school-related resource accessibility and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore. As past studies stated, all other things being equal, learners perform well in Mathematics in schools with more facilities for learning (Chudgar et al., 2015), and school-related resources contribute significantly to the success of schools and learners (Kutsyuruba et al., 2015). Though there was no relationship between school-related resource availability and Mathematics Achievement of IBDP 2 Learners in Singapore, one agreed with other scholars that all other things being equal, learners perform well in Mathematics in schools with more facilities for learning (Chudgar et al., 2015). On the other hand, parental influence significantly impacts achievement that is outsized compared to the effects of school resources (Houtenville & Conway, 2008). Schools with

the highest achievement rates typically had more learners from affluent backgrounds (Elezovic et al., 2022).

The results confirmed a relationship between school-related resource utilisation and Mathematics Achievement of IBDP 2 Learners in South Africa. As past studies indicated, there was a positive correlation between older learners' learning of Mathematics and the availability of classroom technology as a resource at the school level (Jung, Brown & Karp, 2014). Again, no relationship existed between school-related resource utilisation and Mathematics Achievement of IBDP 2 Learners in Singapore. The high achievement in Mathematics in Singapore might be because of appropriate support from educators. This view agrees with the OECD (2020) publication that if learners from all backgrounds have equal chances to do well in school and learn, all schools must have the right support and sufficient, high-quality school-related resources. According to the framework of the current study, Greg Kearsley's Theory of Engagement, when school-based resources are available, accessed and utilised, learners, will participate, engage, and collaborate to attain plausible school achievement.

This study contributed to the relevant literature from different perspectives. First, the low achievement of South Africa in Mathematics compared to Singapore is not a result of the curricula of the two countries. The difference in achievement between South Africa and Singapore still exists even when the learners from the two countries were doing the same curriculum (IBDP Mathematics). The results indicated that South African and Singapore Mathematics Achievement of IBDP 2 Learners depends on the accessibility of school-related resources. For that reason, making school-related resources accessible to

learners may improve their Mathematics achievement in South Africa and Singapore. Second, the current study advanced the work of Chaabane et al. (2021) and Okoji and Olubayo (2021) as it captured the accessibility of school-related resources as an essential factor for Mathematics achievement, other than the curriculum in South Africa and Singapore. Third, the current study confirms that the curriculum in the South African education system is not the key problem. The researcher's theoretical contribution to knowledge was that the difference in Mathematics Achievement of IBDP 2 learners was not springing from the difference in Mathematics curricula of the two countries. It has been confirmed that there is a significant difference in the Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore.

Summary

The current study, although successful, is not without challenges that are paused by COVID-19 restrictions. The challenges ranged from accessibility to study subjects to the return of consent forms. Finally, 179 learners participated in the study. Once more, the researcher presented the results by utilising tables. The analyses indicated no significant difference in the availability, accessibility, and utilisation of the school-related resources of IBDP 2 Learners in South Africa and Singapore. However, the results confirmed a significant difference in the Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore. In addition, the statistics indicated a relationship between school-related resource availability and Mathematics Achievement of IBDP 2 Learners in South Africa. However, no relationship existed between school-related resource availability and the Mathematics Achievement of IBDP 2 Learners in Singapore.

Further indication from the results was a positive relationship between school-related resource accessibility and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore. The statistics indicated an association between school-related resource utilisation and Mathematics Achievement of IBDP 2 Learners in South Africa. However, no relationship existed between school-related resource utilisation and Mathematics Achievement of IBDP 2 Learners in Singapore. There was a mixed bag of results from the analyses, all supported by past studies. Next, we discuss the current study's implications, recommendations for application, and conclusions.

CHAPTER 5: IMPLICATIONS, RECOMMENDATIONS, AND CONCLUSIONS

There is compelling evidence that South African learners perform poorly in Mathematics compared to other world regions (Adler & Pillay, 2017; Spaull & Pretorius, 2019; Spaull & Kotze, 2015). For instance, in grade 9, South Africa obtained very low scores (on a scale of 0 to 1000) in the TIMSS international Mathematics tests introduced in 1995 (Mullis et al., 2020; Spaull & Kotze, 2015). In TIMSS 2019, South Africa got 389 points, placing South Africa in position 38 out of 39 countries, whereas Singapore got 616 points (Mullis, Martin, Foy, Kelly, 2020). Policymakers tried to enhance the curriculum and teaching-learning resources and to increase the number of professional development workshops for Mathematics teachers over the years. However, Singapore had an exclusion from the TIMSS study. Independent schools cannot participate in the International assessment because they predominantly offer foreign curricula (LaRoche & Foy, 2016).

The TIMSS study focused on learners in a particular grade, irrespective of the type of national curriculum the learners are doing or the country is implementing. According to Spaull & Kotze (2015), the test administered to the grade-nine learners was fair and was at the grade level. However, the authors conclude that it might be possible that the alignment assumption of the test with the South African curriculum is false. The current study investigated learners doing the same curriculum in South Africa and Singapore to uncover the truth. Testing learners doing the same curriculum will remove the assumption that poor performance in the TIMSS study tests resulted from the difference in Mathematics curricula offered in each country. Therefore, the current study comparatively investigated if school-related resources are determinants of Mathematics achievement among International Baccalaureate Diploma Learners in South Africa and Singapore.

The current research kept the curriculum the same in both countries. Further, it kept the school type the same as the researcher only investigated International Baccalaureate Diploma Programme Year 2 (IBDP 2) Mathematics Learners in South Africa and Singapore.

The purpose of this correlational method research design study was to find The difference in the availability of school-related resources to IBDP 2 learners in South Africa and Singapore; The difference in the accessibility of the school-related resources of IBDP 2 Learners in South Africa and Singapore; The difference in the school-related resources utilisation of IBDP 2 Learners in South Africa and Singapore; The difference in the Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore; Relationship between school-related resources availability compared to Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore; Relationship between school-related resources accessibility compared to Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore; Relationship between school-related resources utilisation compared to Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore.

In terms of purpose, the current research is an applied exploration and a part of advancement, and as far as the nature and technique, it is correlational research. The current study was not without limitations. The researcher had limited access to information (literature and data). There was not enough published material about achievement in IBDP Mathematics Analysis and Approaches courses as these courses are relatively new (started in May 2019 and first examined in May 2021). The researcher widened the search into published material about achievement on the previous IBDP Mathematics courses for South Africa, Singapore, and all continents, yielding decent results. The search was further widened to Mathematics achievement worldwide, which

resulted in an excellent turnover. The COVID-19 restrictions worldwide posed a real challenge to the accessibility of the subjects for the current study. The researcher relied entirely on telephone and online communication with sampled schools. The researcher gave all documents, instructions and procedures for the data collection process to school secretaries via emails to pass them to administrators, who will then pass them to Coordinators. The researcher perceived this process went relatively well because data started coming in through the online data collection tool (89 and 80 learners from South Africa and Singapore, respectively). The data collection issues might have compromised the reliability and validity of the data collected. However, the researcher was confident that the schools carried out all data collection procedures as written.

Another limitation was that the participants were all IBDP 2 learners completing their high school programme in June. Therefore, the participants are no longer members of their schools and are no longer accessible by their schools. Another limitation was that the researcher was an emerging scholar in research. However, the researcher practised the current study's approach before collecting the data for the main study. Furthermore, to increase the validity and reliability of the study, the researcher could have used more methods for triangulation (Bellido-García et al., 2022; Sirvent, Monteverde & Agullo, 2022).

The researcher obtained permission to use research instrument items from the International Association for the Evaluation of Educational Achievement (IEA) (see Appendix N). The IEA is a global network of national research institutions, academics, government research agencies, and analysts working to study, comprehend, and enhance education internationally. In addition, the researcher obtained permission from the Ministry of Education of Singapore, The Gauteng Department of Education in South Africa, and The Western Cape Department of Education in South Africa.

Consent and assent forms were emailed to all sampled schools with clearly outlined procedures. The researcher further attached consent forms with the online survey of the current research. This chapter will conclude the study by reviewing the implications of the study, recommendations for applications and future research, and conclusions.

Implications

Practical Implications

Following the significant results of the difference in the Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore, it is recommended to send Mathematics teachers (two from each school in South Africa) to Singapore for lesson observations as a professional development exercise (Boylan et al., 2019; Fang, Lee & Yang, 2011; Lindorff et al., 2019; Wong et al., 2020). Studies indicated that in 39 countries that participated in TIMSS 2019 Mathematics studies in grade eight, South Africa obtained position 38, while Singapore was number one (Graham, Mokgwathi & de Villiers, 2021; Mullis et al., 2020). The curriculum was not the problem as the study was conducted on learners doing the same curriculum (IBDP Mathematics AA courses) offered by the International Baccalaureate Organisation in the United Kingdom.

In South Africa, the results indicated a relationship in the availability, accessibility and utilisation of school-related resources compared to Mathematics Achievement of IBDP 2 Learners. While in Singapore, the results confirmed no relationship between the availability and utilisation of school-related resources compared to the Mathematics Achievement of IBDP 2 Learners. However, in Singapore, the results highlighted a positive relationship between the accessibility of school-related resources and the Mathematics Achievement of IBDP 2 Learners. The two countries gave a mixed bag of results for practical implications. Since the South African results indicated a

positive relationship between the school-related resources and Mathematics Achievement of IBDP 2 Learners, improving the availability, accessibility and utilisation of these resources may improve Mathematics achievement. In Singapore, the Mathematics Achievement of IBDP 2 Learners was only positively related to the accessibility to school-related resources but not the availability and utilisation of the school-related resources. Therefore, similar results in South Africa and Singapore were that Mathematics Achievement of IBDP 2 Learners depends on the accessibility of school-related resources. For that reason, making school-related resources accessible to learners may improve their Mathematics achievement in South Africa and Singapore (Chaabane et al., 2021; Okoji & Olubayo, 2021). Therefore, education authorities, school administrators and educators should make school-related resources accessible to all learners so that the learners' Mathematics achievement would improve (Mihaljevic et al., 2019).

Now, the researcher discusses the negative and positive implications of the research results on the South African education system. Educational reform that improves the positive aspects of their systems and reduces any adverse effects is the goal of education authorities everywhere who are interested in determining the factors that influence the achievement of their learners (Elezovic et al., 2022). Since the current research results confirmed a relationship between the accessibility of school-related resources and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore, a system of education with insufficient resources cannot produce positive outcomes (OECD, 2019). Although when education authorities initially invest in the education system has a positive impact on learner achievement, there will come a time when other factors outweigh the impact of additional investments on school-related resources (Elezovic et al., 2022; OECD, 2019). In essence, to achieve more advanced results in Mathematics, less tangible aspects of the quality

of teaching and learning processes will still need to be addressed after every school-related resource has been resolved (OECD, 2019). The takeaway point was that while it is good to ensure that learners access school-related resources to improve their Mathematics achievement, its long-term yields negative results, in the sense that it will be ineffective.

Other studies found that countries like Estonia, with low school-related resources, were among the top-achieving OECD countries in Mathematics (Elezovic et al., 2022; OECD, 2019). Parents may act to reduce school-related resources' impact on academic performance (Houtenville & Conway, 2008). It is worth noting that the only schools that improved in Houtenville & Conway's (2008) study were those that made significant investments in involving parents. This kind of emphasis has the potential to boost learner Mathematics achievement. Successful educational systems should go beyond the acquisition of school-related resources. To ensure quality education, it is commonly recommended to invest in teachers' and principals' ongoing professional development (Elezovic et al., 2022). Another recommendation includes investing in developing lifelong learning skills or expanding ICT use in schools (Elezovic et al., 2022). We, therefore, encourage South African education authorities to focus beyond school-related resources to avoid the adverse effects of concentrating only on school-related resources.

Theoretical Implications

Following the significant results of the difference in the Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore, it is recommended to focus on changes in pedagogical practices and other factors than the curriculum (Deng, Gopinathan & Lee, 2013; Fang et al., 2011; Lindorff et al., 2019; Wong, Kwek & Tan, 2020; Yang & Li, 2022). The curriculum was not the problem as the study was conducted on learners doing the same curriculum (IBDP

Mathematics AA courses) offered by the International Baccalaureate Organisation in the United Kingdom. The current study confirms that the curriculum in the South African education system is not the key problem. The researcher's theoretical contribution to knowledge was that the difference in Mathematics Achievement of IBDP 2 learners was not springing from the difference in Mathematics curricula of the two countries. Other underlying factors need to be investigated in future research. For example, pedagogical aspects, educator-related factors (level of education, educator confidence in their ability to teach Mathematics), educator training programmes in educator training universities and colleges, the diversity of the school's learner population, learner self-confidence (Elezovic et al., 2022; Ker, 2016).

Again, South Africa's results indicated a relationship in the availability, accessibility and utilisation of school-related resources compared to Mathematics Achievement of IBDP 2 Learners. While in Singapore, the results confirmed no relationship between the availability and utilisation of school-related resources compared to the Mathematics Achievement of IBDP 2 Learners. However, in Singapore, the results highlighted a positive relationship between the accessibility of school-related resources and the Mathematics Achievement of IBDP 2 Learners. In Singapore, the Mathematics Achievement of IBDP 2 Learners was only positively related to the accessibility to school-related resources but not the availability and utilisation of the school-related resources. Thus, similar results from South Africa and Singapore showed that the Mathematics Achievement of IBDP 2 Learners depends on the accessibility of school-related resources. For that reason, making school-related resources accessible to learners may improve their Mathematics achievement in South Africa and Singapore (Chaabane et al., 2021; Okoji & Olubayo, 2021). So, the researcher's theoretical contribution to knowledge was that accessibility to school-related

resources might improve Mathematics achievement in IBDP 2 learners, other than the availability or utilisation of the school-related resources.

The current study has shown that, in addition to the school-related resources that help learners learn, other less tangible aspects of school life are just as crucial for improving Mathematics achievement (Elezovic et al., 2022). Setting and maintaining school-related resources is essential for educational systems and school authorities. Increasing learner achievement is frequently the primary objective.

Recommendations for application

The researcher's analyses showed that accessibility to school-related resources positively correlated with the Mathematics Achievement of IBDP 2 Learners doing Mathematics AA courses in South Africa and Singapore. Consequently, the researcher concludes that accessibility to school-related resources significantly affects learner achievement. Of course, south African schools can influence and work hard to improve the accessibility of school-related resources. Still, they can also get good results by visiting Singapore and observing their IBDP 2 Mathematics AA courses' lessons and pedagogical practices.

A standard piece of advice for good Mathematics achievement is to invest in educators' and principals' ongoing professional development (Elezovic et al., 2022). Another suggestion includes investing in the accessibility of school-related resources. Instead, it would be necessary to improve the use of school-related resources by learners, educators, and school principals, as well as their knowledge and ability to use school-related resources for instruction and the conditions that enhance school-related resource use.

Recommendations for future research

Even though this study provided some useful theoretical and practical information, it has some limitations that could lead to new research in the future. Firstly, this research demonstrates that the problem in Mathematics achievement in South African learners is not curriculum-based, mainly because there was a significant difference in the Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore, even when the Mathematics curriculum was the same. In addition, other underlying factors need to be investigated in future research. For example, pedagogical aspects, educator-related factors (level of education, educator confidence in their ability to teach Mathematics), educator training programmes in educator training universities and colleges, the diversity of the school's learner population, learner self-confidence, to name but a few (Elezovic et al., 2022; Ker, 2016).

Secondly, this research addresses the relationship between the accessibility of school-related resources and the Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore. Hence, the research conclusion can further be tested in other contexts. Thirdly, this research is specific to the significant difference and relationship in the availability, accessibility, and utilisation of school-related resources compared to the Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore. Therefore, future researchers can investigate contextual factors on educators' and principals' relationship in school-related resources compared to achievement in learners doing IBDP 2 Mathematics AA courses. Fourthly, this study draws data from South Africa and Singapore. Therefore, it can be extended to other countries to draw more holistic results. Similarly, the conclusion can be tested in other countries.

Fifth, analyses across gender can be made in future research, describing the significant difference between the Mathematics Achievement of male and female IBDP 2 Learners in South Africa and Singapore. Sixth, this study focused only on two characteristics of significant difference in the Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore, and the relationship in the availability, accessibility and utilisation compared to Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore. Hence, future researchers can examine other characteristics, such as learners' views on engaging instruction in lessons in IBDP 2 Mathematics AA courses. Other aspects on how much learners like learning IBDP 2 Mathematics AA courses can be taken, as well as how learners value IBDP Mathematics AA courses in future studies.

Recommendations for stakeholders

The researcher's analyses showed that accessibility to school-related resources positively correlated with the Mathematics Achievement of IBDP 2 Learners doing Mathematics AA courses in South Africa and Singapore. Therefore, educators are advised to ensure that learners have access to the relevant school-related resources used in Mathematics. On the other hand, learners should request educators and heads of schools to provide them with access to their school-related resources. Likewise, parents are advised to supply their children with school-related resources to have access when they need them when doing Mathematics. Heads of schools and education authorities are advised to supply learners and educators with all school-related resources they need to teach and learn Mathematics. Community libraries are advised to have open doors for extended hours so that learners can access school-related resources to enhance their Mathematics learning. An English proverb says raising and educating a child takes a village. All stakeholders should ensure that the learner can access school-related resources in South Africa. A blame game on the

curriculum offered by South Africa should come to a halt, as the curriculum was not the problem. The problem was in the accessibility of learners to Mathematics school-related resources. We do not rule out other underlying factors that need to be investigated by future researchers.

Personal reflection

The COVID-19 pandemic has had a significant impact on the current research. Due to COVID-19 travel restrictions and curfews imposed by the South African and Singaporean governments, I had to adjust my data collection procedures. However, this allowed the researcher to explicitly explain the data collection procedures and trust the people being used in the field for data collection. The collaboration and engagement process strengthened our friendships with school secretaries and administrators.

The researcher used an online quantitative data collection tool (questionnaire) to mitigate the virtual-only approaches permitted during the COVID-19 data collection period. Using only an online questionnaire influenced the researcher to extend the number of items (170) in the instrument to cover all the grounds with similar items to verify the reliability of the responses provided by the research subjects. The response rate was very good (89% for South Africa and 80% for Singapore), probably because of the researcher's constant reminders and encouragement over the phone. Covid-19 offered a chance to use alternative data collection methods. Phones and online surveys that were popular during the pandemic are likely to continue to be important in the new normal after the pandemic.

According to Opoku and others (2022), scholars may need to be aware that COVID-19 will likely influence the conclusions from studies conducted during this period due to excessive reliance on online data collection. According to Opoku and others (2022), the results of online

surveys and interviews frequently have biased data and reliability and validity issues, even though these methods are inexpensive and do not have geographic restrictions.

During the stressful COVID-19 period, Unicaf University's doctoral studies webinars, module lecturers, and motivation from the researcher's supervisor proved extremely helpful. When writing the current research report, the researcher had not been diagnosed with COVID-19. However, four family members contracted COVID-19 and caring for them affected my research schedules and processes. The problem was overcome through encouragement from the sick family member, who told the researcher to continue the research progress, leading to less time loss. However, the current study's time is likely to affect the findings. Therefore, it is recommended that future research explore the current findings in the post-coronavirus time to determine whether there will be similitudes or contrasts. That kind of exploration would validate the findings of the current research.

Obtaining Primary Research Skills

The researcher gained significant primary research skills while conducting the current research. The researcher had never before participated in a research project of this magnitude that required individual primary data collection and analysis. The most well-known quantitative research techniques were learned throughout the study, and the researcher had a useful encounter in conducting a general online survey by administering questionnaires. Furthermore, the researcher has analysed the benefits and drawbacks of other primary data collection methods, such as interviews, focus groups, observations, and so on, in addition to the questionnaire primary data collection method, which provided the primary data. As a result, the researcher has a comprehensive understanding of these data collection methods.

The researcher also recognises the significance of sampling as a whole and the selection of the best sampling method. The researcher has gained a thorough understanding of sampling by critically evaluating the most widely used education sampling methods. However, the most significant contribution to the researcher's growth as a scholar and researcher has been his involvement in collecting and analysing primary data. In this context, it is necessary to emphasise the positive role played by the thesis supervisor, who provided helpful and practical advice for resolving issues that arose at various stages of the research, particularly when resolving issues about the methodology. High Mathematics achievement is more important than ever in today's high demand for science-related careers. Now that the researcher has the skills and knowledge necessary to conduct primary research, the researcher gained a competitive advantage for school-related resources by gathering useful primary data on various aspects of those resources and those resources' effects on IBDP 2 learners' achievement.

Time-management skills improvement

The researcher has likewise significantly profited from the study experience on professional and personal levels by further developing his time-usage abilities. In particular, the research process necessitated extensive planning and preparations for all stages of the study, and all stages had to be carried out systematically from a time perspective. At first, the researcher experienced difficulties in guaranteeing the study's advancement as per the plan. These difficulties primarily surfaced during the research's literature review phase. In particular, the researcher had misjudged the time expected for the literature review and was continually behind the timetable regarding the quantity of literature reviewed. The issue was managed by adjusting the study's time plan and expanding the degree of personal discipline concerning the following set plan.

Particularly, the research process was free of all unnecessary activities, and daily plans were established to carry out a particular portion of the study daily. Simultaneously, arrangements for periodic days off study have been guaranteed inside the arrangement to avoid overstretched and burnout, which could adversely impact the study. The research experience generally improved the researcher's time-management abilities, which has significant personal and professional advantages.

Improving the researcher's self-confidence

The researcher's self-confidence has significantly increased as a result of this research. The increase in self-confidence was primarily accomplished through beating weaknesses and speaking with primary data sources (schools). However, the researcher overcame a sense of insecurity and conducted the research confidently, thanks to tremendous efforts, including spending a lot of time preparing for primary data collection and receiving encouragement from friends and family. In addition, it would not be a misrepresentation to say that the researcher's communication abilities have likewise been extraordinarily improved because of conducting the online survey for the study. There is no doubt that the researcher will significantly profit from the improved degree of self-confidence in the future as a researcher, person, and Mathematics educator. Good Mathematics achievement cannot survive in today's highly sought-after science careers without strong and efficient teaching and learning strategies. In this way, it can be said that the researcher's leadership and teaching abilities have been indirectly enhanced by participating in the current study.

Conclusion

This section will conclude the study by summarising the key research findings related to the research aims and questions and the value and contribution thereof. The study's first aim was

to investigate the difference in the availability of school resources, accessibility, utilisation and Mathematics achievement of IBDP 2 Learners in South Africa and Singapore. The study found no significant difference in the availability, accessibility and utilisation of school-related resources and Mathematics achievement of IBDP 2 Learners in South Africa and Singapore. However, the study confirmed the existence of a significant difference in Mathematics achievement of IBDP 2 Learners in South Africa and Singapore. The study's second aim was to investigate the relationship between school-related resources' availability, accessibility comparatively, and utilisation compared to Mathematics achievement of IBDP 2 Learners in South Africa and Singapore. The study found a positive relationship between the accessibility of school-related resources and the Mathematics achievement of IBDP 2 Learners in South Africa and Singapore. These results also answered the second research question: What is the relationship between school-related resource accessibility and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore?

However, in Singapore, there was no relationship between the availability and utilisation of school-related resources compared to the Mathematics achievement of IBDP 2 Learners. In South Africa, there was a relationship between the availability and utilisation of school-related resources and the Mathematics achievement of IBDP 2 Learners. The results on the relationship in availability and utilisation compared to Mathematics achievement of IBDP 2 Learners answered the first and the third research questions: What is the relationship between school-related resources availability and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore?; What is the relationship between school-related resource utilisation and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore? Hence, the study confirmed a positive relationship between the accessibility of school-related resources and the Mathematics

achievement of IBDP 2 Learners in South Africa and Singapore. Moreover, the positive relationship between the accessibility of school-related resources and the Mathematics achievement of IBDP 2 Learners was the only relationship in both countries.

The researcher's first theoretical contribution to knowledge was that the difference in Mathematics Achievement of IBDP 2 learners was not springing from the difference in Mathematics curricula of South Africa and Singapore. Other underlying factors need to be investigated in future research. The researcher's second theoretical contribution to knowledge was that accessibility to school-related resources might improve Mathematics achievement in IBDP 2 learners, other than the availability or utilisation of the school-related resources. Therefore, investing in educators' and principals' ongoing professional development (Elezovic et al., 2022) and the accessibility of school-related resources is vital.

Future researchers can investigate contextual factors on educators' and principals' relationship in school-related resources compared to achievement in learners doing IBDP 2 Mathematics AA courses. Analyses across gender can be made in future research, describing the significant difference between the Mathematics Achievement of male and female IBDP 2 Learners in South Africa and Singapore. Future researchers can also examine other characteristics, such as learners' views on engaging instruction in lessons in IBDP 2 Mathematics AA courses. Other aspects on how much learners like learning IBDP 2 Mathematics AA courses can be taken, as well as how learners value IBDP Mathematics AA courses in future studies.

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APPENDICES

Appendix A: Unicaf University Research Ethics Application Form Doctoral Studies

REAF_DS - Version 3.1

UNICAF UNIVERSITY
RESEARCH ETHICS APPLICATION FORM
DOCTORAL STUDIES

UREC USE ONLY
Application No:

Date Received:

Student's Name: Abel Wilson Magongo

Student's E-mail Address: awmagongo@gmail.com

Student's ID #: R1809D6356125

Supervisor's Name: Dr Muraina Kamilu Olanrewaju

University Campus: Unicaf University Zambia (UUZ)

Program of Study: UUM: EdD - Doctorate of Education

Research Project Title:

Comparative Study of School-Related Resources as Determinants of Mathematics Achievement Among International Baccalaureate Diploma Learners in South Africa and Singapore

1. Please state the timelines involved in the proposed research project:

2. **External Research Funding (if applicable):**

2.a. Do you have any external funding for your research?

☐ YES ☑ NO

If YES, please answer questions **2b** and **2c**.

2.b. List any external (third party) sources of funding you plan to utilise for your project. You need to include full details on the source of funds (e.g. state, private or individual sponsor), any prior / existing or future relationships between the funding body / sponsor and any of the principal investigator(s) or co-investigator(s) or student researcher(s), status and timeline of the application and any conditions attached.

2.c. If there are any perceived ethical issues or potential conflicts of interest arising from applying or and receiving external funding for the proposed research then these need to be fully disclosed below and also further elaborated on, in the relevant sections on ethical considerations later on in this form.

Estimated Start Date: 01-Feb-2022 Estimated End Date: 31-May-2022

3. **The research project**

3.a. Project Summary:

In this section fully describe the purpose and underlying rationale for the proposed research project. Ensure that you pose the research questions to be examined, state the hypotheses, and discuss the expected results of your research and their potential.

It is important in your description to use plain language so it can be understood by all members of the UREC, especially those who are not necessarily experts in the particular discipline. To that effect ensure that you fully explain / define any technical terms or discipline-specific terminology (use the space provided in the box).

When compared to Singapore, South Africa has not been doing well in grade-eight international Mathematics tests they have been writing since 1995. Even when the TIMSS study team agreed to accept grade-nine in South Africa instead of grade-eight, as is the case with the rest of the world, South Africa still performed very poorly in the tests. In recent years, the department of basic education has been trying very hard to improve the education system from grade-R (reception) through grade-12 to NO success. However, in Singapore, as a choice and policy of the local Ministry of Education, the TIMSS study is conducted only on learners doing their national curriculum, not on learners doing the International Baccalaureate (IB) Mathematics curriculum. In South Africa, the TIMSS study is conducted across all schools, irrespective of the schools' curriculum. To that effect, this can be likened to comparing two apple juices made from different types of apples, with the assumption that the apples, though different, are of the same chemical composition. Therefore, this research plans to survey using a questionnaire, South African and Singapore learners doing only the well-established international education system known as International Baccalaureate (IB) Diploma Mathematics. My original contribution to knowledge is information on South African International Baccalaureate Diploma Programme Year 2 (IBDP 2) learners compared with IBDP 2 of Singapore. Unfortunately, from the literature the current researcher has read, no study similar to mine was conducted in comparison of the two countries in IB Diploma Mathematics performance.

RESEARCH QUESTIONS

1. What is the relationship between school-related resources availability and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore? 2. What is the relationship between school-related resources accessibility and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore? 3. What is the relationship between school-related resources utilisation and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore?

3.b. Significance of the Proposed Research Study and Potential Benefits:

Outline the potential significance and/or benefits of the research (use the space provided in the box).

South Africa has been trying to solve its problems in its education system for over 20 years now, with no success. The results of this study will inform South African policymakers, education reformers, teachers, principals, parents, and other stakeholders about necessary interventions needed to improve the South African Mathematics achievement to match that of South Africa's international counterpart.

The stakeholders in South Africa should know if the problem is with the South African school-related resources, the South African national Mathematics curriculum, or the pedagogical approach (practice) to Mathematics.

This study will point at areas that need reform in the South African Mathematics curriculum. In addition, it will inform policymakers as to where money should be best spent in South African Mathematics education.

4. **Project execution:**

4.a. The following study is an:

- [x] experimental study (primary research)
- [ ] desktop study (secondary research)
- [x] desktop study using existing databases involving information of human/animal subjects
- [ ] Other

If you have chosen 'Other' please Explain:

Abel Wilson Magongo R1809D6356123

4.b. Methods. The following study will involve the use of:

Method	Materials / Tools
Qualitative:	[ ] Face to Face Interviews
	[ ] Phone Interviews
	[ ] Face to Face Focus Groups
	[ ] Online Focus Groups
	[ ] Other *

Quantitative:

- ☐ Face to Face Questionnaires
- ☑ Online Questionnaires
- ☐ Experiments
- ☐ Tests
- ☐ Other *

*If you have chosen 'Other' please Explain:

5. Participants:

5a. Does the Project involve the recruitment and participation of additional persons other than the researcher(s) themselves?

- ☑ YES **If YES, please complete all following sections.**
- ☐ NO **If NO, please directly proceed to Question 7.**

5 b. Relevant Details of the Participants of the Proposed Research

State the number of participants you plan to recruit, and explain in the box below how the total number was calculated.

Number of participants: 480

At Waterford United World College (IBDP school), there are currently about 60 IBDP 2 Mathematics AA learners in 2021. The numbers are assumed to be the same with all the eight sampled schools (six for the main study and two for the field study). Therefore, if 60 learners are from each participating school, that will give 480 participants for the eight schools combined.

Describe important characteristics such as: demographics (e.g. age, gender, location, affiliation, level of fitness, intellectual ability etc). It is also important that you specify any inclusion and exclusion criteria that will be applied (e.g. eligibility criteria for participants).

Age range From 17 To 19

Gender ☑ Female ☑ Male

Eligibility Criteria:

- Inclusion criteria

  IBDP 2 Learners doing IBDP Mathematics Analysis and Approaches in 2021/2022 academic year.
  IBDP 2 - stands for International Baccalaureate Diploma Programme Year 2

- Exclusion criteria

  There is no school doing local-national curriculum, school of special needs students, students with special needs, students with disabilities, students not using English as a medium of instruction in Mathematics.

Disabilities

There are no students with disabilities will take part in this study. These are students who have physical disabilities such that they cannot participate in

Other relevant information (use the space provided In the box):

In the TIMSS 2015 study, school-level exclusions in Singapore consisted of special needs schools and private schools, which are mainly foreign-system schools. In South Africa, school-level exclusions in the TIMSS 2015 study consisted of small schools (size < 8) and special needs schools. The current research takes the foreign-system schools (IBDP schools), which are predominantly private.

Abel Wilson Magongo R1809D6356125

5 c. Participation & Research setting:

Clearly describe which group of participants is completing/participating in the material(s)/ tool(s) described in 5b above (use the space provided in the box).

The primary study sample comprises three IBDP schools from South Africa and three

IBDP schools from Singapore. The sample of the field study has two schools from Singapore. Therefore, only eight schools are participating in the whole study. South Africa has only three IBDP schools (no sampling needed), while Singapore has about 27 IBDP schools. A stratified random sampling procedure will be used to come up with the five participating schools in Singapore. An addition of one school will be added into the sample if there is a sampled school that refuses to participate in the study. The participating learners are IBDP 2 Mathematics AA (Analysis and Approaches) learners doing IBDP 2 in the 2021/2022 academic year.

5 d. Recruitment Process for Human Research Participants:

Clearly describe how the potential participants will be identified, approached and recruited (use the space provided in the box).

In South Africa, the researcher will fill a prescribed province's Research Request form to request permission to conduct research in schools in the province's districts and

provide the province with all relevant details about the research study to be undertaken. In the case of Singapore, the same process will be done with the Ministry of Education of Singapore by filling an online application form.

The researcher will contact school principals for sampled schools to solicit participation in Singapore and South Africa. If a school declines to participate, the first substitute school will be approached, and the procedure will be repeated.

On the school's advice, parents' permission for students to participate will be sought with parents' notification with a consent form to sign. In each approach, parents will be informed that their students could opt-out from participating. Students will also be given as

5 e. Research Participants Informed Consent.
Select below which categories of participants will participate in the study. Complete the relevant Informed Consent form and submit it along with the REAF form.

Yes	No	Categories of participants	Form to be completed
☑	☐	Typically Developing population(s) above the maturity age *	Informed Consent Form
☑	☐	Typically Developing population(s) under the maturity age *	Guardlan Informed Consent Form

* Maturity age is defined by national regulations in laws of the country in which the research is being conducted.

5 f. Relationship between the principal investigator and participants.

Is there any relationship between the principal investigator (student), co-investigators(s), (supervisor) and participant(s)? For example, if you are conducting research in a school environment on students in your classroom (e.g. instructor-student).

☐ YES ☑ NO

If YES, specify (use the space provided in the box).

6. ☐ YES ☑ NO Potential Risks of the Proposed Research Study.

If YES, specify below and answer the question 6 a.II.

6 a. I. Are there any potential risks, psychological harm and/or ethical issues associated with the proposed research study, other than risks pertaining to everyday life events (such as the risk of an accident when travelling to a remote location for data collection)?

6 a.Ii Provide information on what measures will be taken in order to exclude or minimise risks described in 6.a.i.

N/A

6 b. Choose the appropriate option

		Yes	No
i.	Will you obtain written informed consent form from all participants?	☑	☐
ii.	Does the research involve as participants, people whose ability to give free and informed consent is in question?	☐	☑
iii.	Does this research involve participants who are children under maturity age? **If you answered YES to question iii, complete all following questions.** **If you answered NO to question iii, do not answer Questions iv, v, vi and proceed to Questions vii, viii, ix and x.**	☑	☐
iv.	Will the research tools be implemented in a professional educational setting in the presence of other adults (i.e. classroom in the presence of a teacher)?	☑	☐
v.	Will informed consent be obtained from the legal guardians (i.e. parents) of children?	☑	☐
vi.	Will verbal assent be obtained from children?	☑	☐
vii.	Will all data be treated as confidential? If NO, explain why confidentiality of the collected data is not appropriate for this proposed research project, providing details of how all participants will be informed of the fact that any data which they will provide will not be confidential.	☑	☐
viii.	Will all participants /data collected be anonymous? If NO, explain why and describe the procedures to be used to ensure the anonymity of participants and/or confidentiality of the collected data both during the conduct of the research and in the subsequent release of its findings.	☑	☐

		Yes	No
ix.	Have you ensured that personal data and research data collected from participants will be securely stored for five years?	☑	☐
x.	Does this research involve the deception of participants? If YES, describe the nature and extent of the deception involved. Explain how and when the deception will be revealed, and who will administer this debrief to the participants.	☐	☑

6 c. i. Are there any other ethical issues associated with the proposed research study that are not already adequately covered in the preceding sections?

☐ Yes ☑ No

If YES, specify (maximum 150 words).

6.c.ii Provide information on what measures will be taken in order to exclude or minimise ethical issues described in 6.c.i.

N/A

6 I d. ndicate the Risk Rating.

☐ Hlgh ☑ Low

Abel Wilson Magongo R1809D635612

7. Further Approvals

Are there any other approvals required (in addition to ethics clearance from UREC) in order to carry out the proposed research study?

☑ YES ☐ NO

If YES, specify (maximum 100 words).

Approval will also be sought from each province where there is a sampled school in South Africa. In Singapore, permission will be sought from the Ministry of Education.

Further approval will be sought from principals of each sampled school in both countries,

Singapore and South Africa. Permission will be requested from the heads of schools for t

8. Application Checklist

Mark √ if the study involves any of the following:

- [x] Children and young people under 18 years of age, vulnerable population such as children with special educational needs (SEN), racial or ethnic minorities, socioeconomically disadvantaged, pregnant women, elderly, malnourished people, and ill people.
- [ ] Research that foresees risks and disadvantages that would affect any participant of the study such as anxiety, stress, pain or physical discomfort, harm risk (which is more than is expected from everyday life) or any other act that participants might believe is detrimental to their wellbeing and / or has the potential to / will infringe on their human rights / fundamental rights.
- [ ] Risk to the well-being and personal safety of the researcher.
- [ ] Administration of any substance (food / drink / chemicals / pharmaceuticals / supplements / chemical agent or vaccines or other substances (including vitamins or food substances) to human participants.
- [ ] Results that may have an adverse impact on the natural or built environment.

9. Further documents

Check that the following documents are attached to your application:

		ATTACHED	NOT APPLICABLE
1	Recruitment advertisement (if any)	☐	☑
2	Informed Consent Form / Guardian Informed Consent Form	☑	☐
3	Research Tool(s)	☑	☐
4	Gatekeeper Letter	☐	☑
5	Any other approvals required in order to carry out the proposed research study, e.g., institutional permission (e.g. school principal or company director) or approval from a local ethics or professional regulatory body.	☑	☐

10. Final Declaration by Applicants:

(a) I declare that this application is submitted on the basis that the information it contains is confidential and will only be used by Unicaf University for the explicit purpose of ethical review and monitoring of the conduct of the research proposed project as described in the preceding pages.

(b) I understand that this information will not be used for any other purpose without my prior consent, excluding use intended to satisfy reporting requirements to relevant regulatory bodies.

(c) The information in this form, together with any accompanying information, is complete and correct to the best of my knowledge and belief and I take full responsibility for it.

(d) I undertake to abide by the highest possible international ethical standards governing the Code of Practice for Research Involving Human Participants, as published by the UN WHO Research Ethics Review Committee (ERC) on http://www.who.int/ethics/research/en/ and to which Unicaf University aspires to.

(e) In addition to respect any and all relevant professional bodies' codes of conduct and/or ethical guidelines, where applicable, while in pursuit of this research project.

☑ **I agree with all points listed under Question 10**

Student's Name: Abel Wilson Magongo

Supervisor's Name: Dr Muraina Kamilu Olanrewaju

Date of Application: 14-Nov-2021

Important Note:
Save your completed form (we suggest you also print a copy for your records) and then submit it to your UU Dissertation/project supervisor (tutor). **In the case of student projects, the responsibility lies with the Faculty Dissertation/Project Supervisor.** If this is a student application, then it should be submitted via the relevant link in the VLE. Please submit only electronically filled in copies; **do not** hand fill and submit scanned paper copies of this application.

Appendix B: Unicaf University Research Ethics Committee Decision

UNICAF UNIVERSITY

UREC Decision, Version 2.0

Unicaf University Research Ethics Committee Decision

Student's Name: Abel Wilson Magongo

Student's ID #: R1809D6356125

Supervisor's Name: Dr Muraina Kamilu Olanrewaju

Program of Study: UU-EDUD-900-3-ZM

Offer ID /Group ID: O30634G31845

Dissertation Stage: DS 3

Research Project Title:

Comparative Study of School-Related Resources as Determinants of Mathematics Achievement Among International Baccalaureate Diploma Learners in South Africa and Singapore

Comments: No comments.

Decision*: A. Approved without revision or comments

Date: 23-Dec-2021

*Provisional approval provided at the Dissertation Stage 1, whereas the final approval is provided at the Dissertation stage 3. The student is allowed to proceed to data collection following the final approval.

Appendix C: Gauteng Department of Education Application Letter to Conduct Research in Gauteng Province - South Africa

29 Royland Crescent
HOUT BAY
WESTERN CAPE
SOUTH AFRICA

26 November 2021

The Research Coordinator
GAUTENG DEPARTMENT OF EDUCATION
SOUTH AFRICA

Dear Sir/Madam

Re: Request for a Permission to Conduct a Study IBDP Schools in Gauteng Province

I am Abel Wilson Magongo, a Doctorate of Education (EdD) student at Unicaf University, currently conducting a research project titled "Comparative Study of School-Related Resources as Determinants of Mathematics Achievement Among International Baccalaureate Diploma Learners in South Africa and Singapore". Unicaf University is accredited by the British Accreditation Council based in the UK. The associated institutions to Unicaf University are Liverpool John Moores University in the UK, the University of Suffolk in the UK, the University of East London in the UK, and the University of Zambia. I am currently registered with the Zambia campus. In addition, Unicaf University and its associated institutions are registered and approved by some different jurisdictions in countries worldwide. I will receive a Liverpool John Moores University and a University of East London awards on successful completion.

I am requesting permission to conduct a study on IBDP learners doing the IB Diploma Mathematics AA course in their last year of study (IBDP 2) at the American International School of Johannesburg. Data collection will start from 1 February 2022 to 31 March 2022. The data will be collected through a questionnaire that will be sent online only. There will be no in-person contact with participants due to covid-19 protocols.

South Africa has been trying to solve its problems in its education system for over 20 years now, with no success. The results of this study will inform South African policymakers, education reformers, teachers, principals, parents, and other stakeholders about necessary interventions needed to improve the South African Mathematics achievement to match that of South Africa's international counterpart.

The stakeholders in South Africa should know if the problem is with the South African school-related resources, the South African national Mathematics curriculum, or the pedagogical approach (practice) to Mathematics.

This study will point at areas that need reform in the South African Mathematics curriculum. In addition, it will inform policymakers as to where money should be best spent in South African Mathematics education.

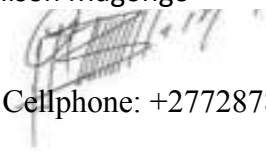
I am committed to ensuring participants' voluntarily participation in the research project and guaranteeing no potential risks or harms. Participants have the right to withdraw at any stage (prior or post the completion) of the research without any consequences and without providing any explanation. In these cases, the data collected will be deleted. All data and information collected will be coded and will not be accessible to anyone outside this research. Data described and included in dissemination activities will only refer to coded information ensuring beyond the bounds of possibility participant identification.

If you need more information, please contact the Project Supervisor, Dr K. O. Muraina, School of Doctoral Studies, Unicaf University, email: m.olanrewaju@unicaf.org. Thank you for your assistance in the learning activity.

With permission from Unicaf University, I am willing to forward the research report upon completion of the study. I am looking forward to your favourable response.

Kind regards,

Abel Wilson Magongo



Cellphone: +27728782329

INFORMATION:

Student Name: Abel Wilson Magongo

Email Address: awmagongo@gmail.com

School of Doctoral Studies

Unicaf University

Telephone: +2348034592046

Email: m.olanrewaju@unicaf.org

Appendix D: Gauteng Department of Education Research Approval Letter to Conduct Research in Gauteng Province

GAUTENG PROVINCE
Department: Education
REPUBLIC OF SOUTH AFRICA

8/4/4/1/2

GDE RESEARCH APPROVAL LETTER

Date:	24 January 2022
Validity of Research Approval:	08 February 2022– 30 September 2022 2022/30
Name of Researcher:	Magongo AW
Address of Researcher:	29 Royland Crescent
	Hout Bay
	Cape Town
Telephone Number:	072 878 2329
Email address:	awmagongo@gmail.com
Research Topic:	Comparative Study of school-related resources as determinants of mathematics achievement among International Baccalaureate Diploma learners in South Africa
Type of qualification	PhD
Number and type of schools:	2 Secondary Schools
District/s/HO	Johannesburg North

Re: Approval in Respect of Request to Conduct Research

This letter serves to indicate that approval is hereby granted to the above-mentioned researcher to proceed with research in respect of the study indicated above. The onus rests with the researcher to negotiate appropriate and relevant time schedules with the school/s and/or offices involved to conduct the research. A separate copy of this letter must be presented to both the School (both Principal and SGB) and the District/Head Office Senior Manager confirming that permission has been granted for the research to be conducted.

24/01/2022

The following conditions apply to GDE research. The researcher may proceed with the above study subject to the conditions listed below being met. Approval may be withdrawn should any of the conditions listed below be flouted:

Making education a societal priority

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

1. *Letter that would indicate that the said researcher/s has/have been granted permission from the Gauteng Department of Education to conduct the research study.*
2. *The District/Head Office Senior Manager/s must be approached separately, and in writing, for permission to involve District/Head Office Officials in the project.*
3. ***Because of COVID 19 pandemic researchers can ONLY collect data online, telephonically or may make arrangements for Zoom with the school Principal. Requests for such arrangements should be submitted to the GDE Education Research and Knowledge Management directorate. The approval letter will then indicate the type of arrangements that have been made with the school.***
4. ***The Researchers are advised to make arrangements with the schools via Fax, email or telephonically with the Principal.***
5. *A copy of this letter must be forwarded to the school principal and the chairperson of the School Governing Body (SGB) that would indicate that the researcher/s have been granted permission from the Gauteng Department of Education to conduct the research study.*
6. *A letter / document that outline the purpose of the research and the anticipated outcomes of such research must be made available to the principals, SGBs and District/Head Office Senior Managers of the schools and districts/offices concerned, respectively.*
7. *The Researcher will make every effort obtain the goodwill and co-operation of all the GDE officials, principals, and chairpersons of the SGBs, teachers and learners involved. Persons who offer their co-operation will not receive additional remuneration from the Department while those that opt not to participate will not be penalised in any way.*
8. *Research may only be conducted after school hours so that the normal school programme is not interrupted. The Principal (if at a school) and/or Director (if at a district/head office) must be consulted about an appropriate time when the researcher/s may carry out their research at the sites that they manage.*
9. *Research may only commence from the second week of February and must be concluded before the beginning of the last quarter of the academic year. If incomplete, an amended Research Approval letter may be requested to conduct research in the following year.*
10. *Items 6 and 7 will not apply to any research effort being undertaken on behalf of the GDE. Such research will have been commissioned and be paid for by the Gauteng Department of Education.*
11. *It is the researcher's responsibility to obtain written parental consent of all learners that are expected to participate in the study.*
12. *The researcher is responsible for supplying and utilising his/her own research resources, such as stationery, photocopies, transport, faxes and telephones and should not depend on the goodwill of the institutions and/or the offices visited for supplying such resources.*
13. *The names of the GDE officials, schools, principals, parents, teachers and learners that participate in the study may not appear in the research report without the written consent of each of these individuals and/or organisations.*
14. *On completion of the study the researcher/s must supply the Director: Knowledge Management & Research with one Hard Cover bound and an electronic copy of the research.*
15. *The researcher may be expected to provide short presentations on the purpose, findings and recommendations of his/her research to both GDE officials and the schools concerned.*
16. *Should the researcher have been involved with research at a school and/or a district/head office level, the Director concerned must also be supplied with a brief summary of the purpose, findings and recommendations of the research study.*

The Gauteng Department of Education wishes you well in this important undertaking and looks forward to examining the findings of your research study.

Kind regards

.....

Mr Gumani Mukatuni
Acting CES: Education Research and Knowledge Management

DATE: 24/01/2022

Office of the Director: Education Research and Knowledge Management
7th Floor, 17 Simmonds Street, Johannesburg, 2001
Tel: (011) 355 0488
Email: Faith.Tshabalala@gauteng.gov.za
Website: www.education.gpg.gov.za

Appendix E: Western Cape Department of Education Application Letter to Conduct Research in Western Cape Province - South Africa

29 Royland Crescent
HOUT BAY
WESTERN CAPE
SOUTH AFRICA

26 November 2021

The Research Coordinator
WESTERN CAPE DEPARTMENT OF EDUCATION
SOUTH AFRICA

Dear Sir/Madam

Re: Request for a Permission to Conduct a Study in IBDP Schools in the Western Cape Province

I am Abel Wilson Magongo, a Doctorate of Education (EdD) student at Unicaf University, currently conducting a research project titled "Comparative Study of School-Related Resources as Determinants of Mathematics Achievement Among International Baccalaureate Diploma Learners in South Africa and Singapore". Unicaf University is accredited by the British Accreditation Council based in the UK. The associated institutions to Unicaf University are Liverpool John Moores University in the UK, the University of Suffolk in the UK, the University of East London in the UK, and the University of Zambia. I am currently registered with the Zambia campus. In addition, Unicaf University and its associated institutions are registered and approved by some different jurisdictions in countries worldwide. I will receive a Liverpool John Moores University and a University of East London awards on successful completion.

I am requesting permission to conduct a study on IBDP learners doing the IB Diploma Mathematics AA course in their last year of study (IBDP 2) at the American International School of Johannesburg. Data collection will start from 1 February 2022 to 31 March 2022. The data will be collected through a questionnaire that will be sent online only. There will be no in-person contact with participants due to covid-19 protocols.

South Africa has been trying to solve its problems in its education system for over 20 years now, with no success. The results of this study will inform South African policymakers, education reformers, teachers, principals, parents, and other stakeholders about necessary interventions needed to improve the South African Mathematics achievement to match that of South Africa's international counterpart.

The stakeholders in South Africa should know if the problem is with the South African school-related resources, the South African national Mathematics curriculum, or the pedagogical approach (practice) to Mathematics.

This study will point at areas that need reform in the South African Mathematics curriculum. In addition, it will inform policymakers as to where money should be best spent in South African Mathematics education.

I am committed to ensuring participants' voluntarily participation in the research project and guaranteeing no potential risks or harms. Participants have the right to withdraw at any stage (prior or post the completion) of the research without any consequences and without providing any explanation. In these cases, the data collected will be deleted. All data and information collected will be coded and will not be accessible to anyone outside this research. Data described and included in dissemination activities will only refer to coded information ensuring beyond the bounds of possibility participant identification.

If you need more information, please contact the Project Supervisor, Dr K. O. Muraina, School of Doctoral Studies, Unicaf University, email: m.olanrewaju@unicaf.org. Thank you for your assistance in the learning activity.

With permission from Unicaf University, I am willing to forward the research report upon completion of the study. I am looking forward to your favourable response.

Kind regards,

Abel Wilson Magongo

Cellphone: +27728782329

INFORMATION:
Student Name: Abel Wilson Magongo
Email Address: awmagongo@gmail.com
School of Doctoral Studies
Unicaf University
Telephone: +2348034592046
Email: m.olanrewaju@unicaf.org

Appendix F: Western Cape Department of Education Research Approval Letter

Directorate: Research

meshack.kanzi@westerncape.gov.za
Tel: +27 021 467 2350
Fax: 086 590 2282

Private Bag x9114, Cape Town, 8000 wced.wcape.gov.za

REFERENCE: 20220119-9128

ENQUIRIES: Mr M Kanzi

Mr Abel Magongo
29 Royland Crescent
Hout Bay
Cape Town
7806

Mr Abel Magongo,

RESEARCH PROPOSAL: COMPARATIVE STUDY OF SCHOOL-RELATED RESOURCES AS DETERMINANTS OF MATHEMATICS ACHIEVEMENT AMONG INTERNATIONAL BACCALAUREATE DIPLOMA LEARNERS IN SOUTH AFRICA AND SINGAPORE.

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **19 January 2022 till 31 May 2022.**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Mr M Kanzi at the contact numbers above quoting the reference number.

8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

The Director: Research Services Western Cape Education Department
Private Bag X9114
CAPE TOWN
8000

We wish you success in your research.

Kind regards,
Meshack Kanzi
Directorate: Research
DATE: 19 January 2022

Appendix G: Singapore Ministry of Education Application Letter to Conduct research in Singapore

29 Royland Crescent
HOUT BAY
WESTERN CAPE
SOUTH AFRICA

14 November 2021

The Research Coordinator
THE MINISTRY OF EDUCATION
SINGAPORE

Dear Sir/Madam

Re: Request for a Permission to Conduct a Study at International Baccalaureate Diploma Programme Schools in Singapore from 1 February 2022 to 31 March 2022

I am Abel Wilson Magongo, a Doctorate of Education (EdD) student at Unicaf University, currently conducting a research project titled "Comparative Study of School-Related Resources as Determinants of Mathematics Achievement Among International Baccalaureate Diploma Learners in South Africa and Singapore". Unicaf University is accredited by the British Accreditation Council based in the UK. The associated institutions to Unicaf University are Liverpool John Moores University in the UK, the University of Suffolk in the UK, the University of East London in the UK, and the University of Zambia. I am currently registered with the Zambia campus. In addition, Unicaf University and its associated institutions are registered and approved by some different jurisdictions in countries worldwide. I will receive a Liverpool John Moores University and a University of East London awards on successful completion.

I am requesting permission to conduct a study on IBDP learners doing the IB Diploma Mathematics AA course in their last year of study (IBDP 2) at the International Baccalaureate Diploma Programme Schools in Singapore. Data collection will start from 1 February 2022 to 31 March 2022. The data will be collected through a questionnaire that will be sent online only. There will be no in-person contact with participants due to covid-19 protocols.

South Africa has been trying to solve its problems in its education system for over 20 years now, with no success. The results of this study will inform South African policymakers, education reformers, teachers, principals, parents, and other stakeholders about necessary interventions needed to improve the South African Mathematics achievement to match that of South Africa's international counterpart.

The stakeholders in South Africa should know if the problem is with the South African school-related resources, the South African national Mathematics curriculum, or the pedagogical approach (practice) to Mathematics.

This study will point at areas that need reform in the South African Mathematics curriculum. In addition, it will inform policymakers as to where money should be best spent in South African Mathematics education.

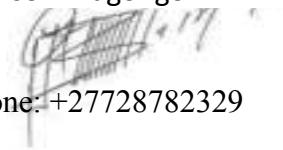
I am committed to ensuring participants' voluntarily participation in the research project and guaranteeing no potential risks or harms. Participants have the right to withdraw at any stage (prior or post the completion) of the research without any consequences and without providing any explanation. In these cases, the data collected will be deleted. All data and information collected will be coded and will not be accessible to anyone outside this research. Data described and included in dissemination activities will only refer to coded information ensuring beyond the bounds of possibility participant identification.

If you need more information, please contact the Project Supervisor, Dr K. O. Muraina, School of Doctoral Studies, Unicaf University, Telephone: +2348034592046 or email: m.olanrewaju@unicaf.org. Thank you for your assistance in the learning activity.

With permission from Unicaf University, I am willing to forward the research report upon completion of the study. I am looking forward to your favourable response.

Kind regards,

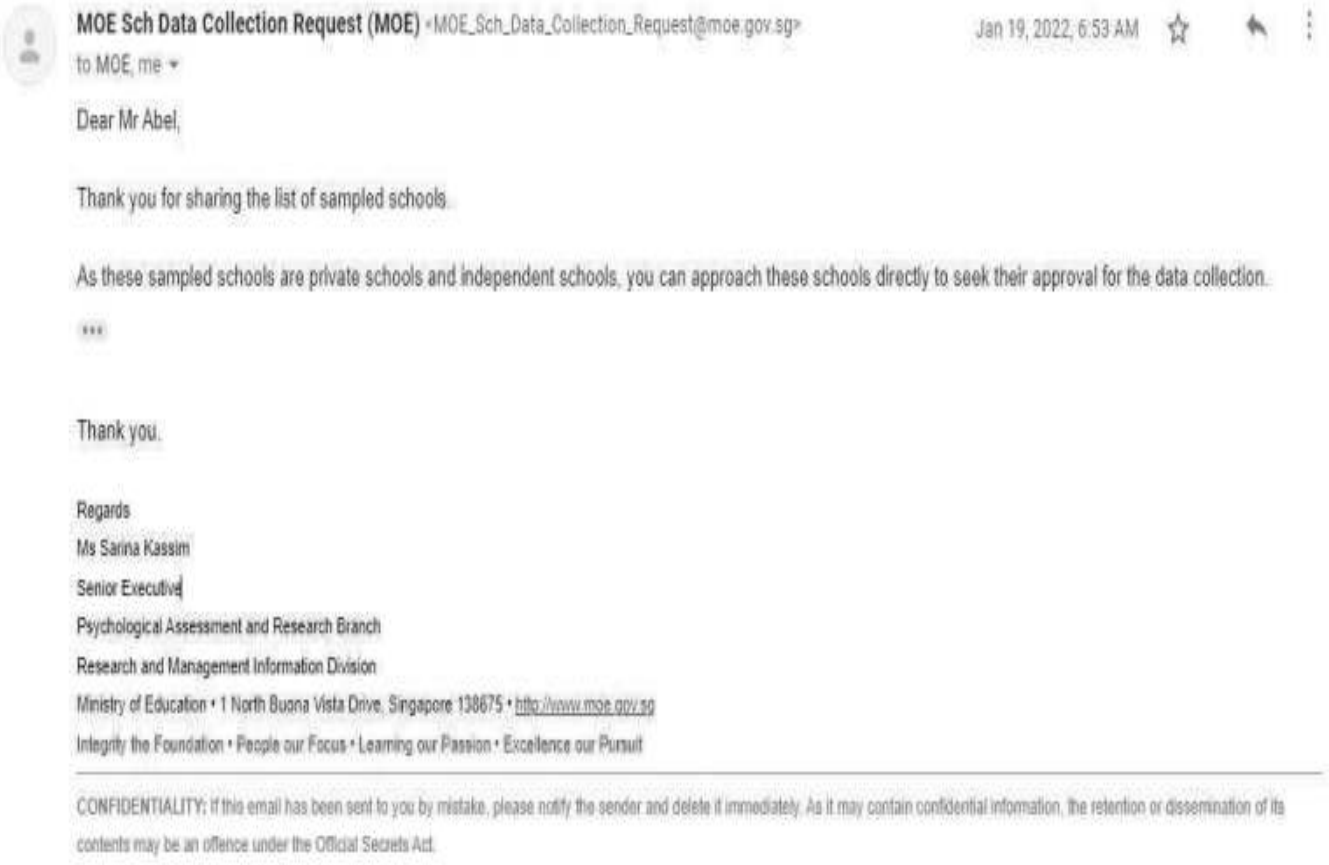
Abel Wilson Magongo



Cellphone: +27728782329

INFORMATION:
Student Name: Abel Wilson Magongo
Email Address: awmagongo@gmail.com
School of Doctoral Studies
Unicaf University
Telephone: +2348034592046
Email: m.olanrewaju@unicaf.org

Appendix H: Singapore Ministry of Education Approval to Conduct research in Singapore



MOE Sch Data Collection Request (MOE) <MOE_Sch_Data_Collection_Request@moe.gov.sg> Jan 19, 2022, 6:53 AM

to MOE, me

Dear Mr Abel,

Thank you for sharing the list of sampled schools.

As these sampled schools are private schools and independent schools, you can approach these schools directly to seek their approval for the data collection.

...

Thank you.

Regards
Ms Sarina Kassim
Senior Executive
Psychological Assessment and Research Branch
Research and Management Information Division
Ministry of Education • 1 North Buona Vista Drive, Singapore 138675 • http://www.moe.gov.sg
Integrity the Foundation • People our Focus • Learning our Passion • Excellence our Pursuit

CONFIDENTIALITY: If this email has been sent to you by mistake, please notify the sender and delete it immediately. As it may contain confidential information, the retention or dissemination of its contents may be an offence under the Official Secrets Act.

Appendix I: School Principal Informed Consent Form

29 Royland Crescent
HOUT BAY
WESTERN CAPE

25 January 2022

The Principal
[**Full Address**]

[**COUNTRY**]

Dear Mr/s [**Name of Principal**]

Re: Request for a Permission to Conduct a Study at [Name of IBDP School] from 8 February 2022 to 31 March 2022

I am Abel Wilson Magongo, a Doctorate of Education (EdD) student at Unicaf University, currently conducting a research project titled “Comparative Study of School-Related Resources as Determinants of Mathematics Achievement Among International Baccalaureate Diploma Learners in South Africa and Singapore”. Unicaf University is accredited by the British Accreditation Council based in the UK. The associated institutions to Unicaf University are Liverpool John Moores University in the UK, the University of Suffolk in the UK, the University of East London in the UK, and the University of Zambia. I am currently registered with the Zambia campus. In addition, Unicaf University and its associated institutions are registered and approved by some different jurisdictions in countries worldwide. I will receive a Liverpool John Moores University and a University of East London awards on successful completion.

I am requesting permission to conduct a study at Hout Bay International School on IBDP learners doing IB Diploma Mathematics AA course on their last year of study (IBDP 2). Data collection will start from 8 February 2022 to 31 March 2022. The data will be collected through a questionnaire that will be sent online only. There will be no in-person contact with participants due to covid-19 protocols.

South Africa has been trying to solve its problems in its education system for over 20 years now, with no success. The results of this study will inform South African policymakers, education reformers, teachers, principals, parents, and other stakeholders about necessary interventions needed to improve the South African Mathematics achievement to match that of South Africa’s international counterpart.

The stakeholders in South Africa should know if the problem is with the South African school-related resources, the South African national Mathematics curriculum, or the pedagogical approach (practice) to Mathematics.

This study will point at areas that need reform in the South African Mathematics curriculum. In addition, it will inform policymakers as to where money should be best spent in South African Mathematics education.

I am committed to ensuring participants' voluntarily participation in the research project and guaranteeing no potential risks or harms. Participants have the right to withdraw at any stage (prior or post the completion) of the research without any consequences and without providing any explanation. In these cases, the data collected will be deleted. All data and information collected will be coded and will not be accessible to anyone outside this research. Data described and included in dissemination activities will only refer to coded information ensuring beyond the bounds of possibility participant identification.

If you need more information, please contact the Project Supervisor, Dr K. O. Muraina, School of Doctoral Studies, Unicaf University, email: m.olanrewaju@unicaf.org. Thank you for your assistance in the learning activity.

With permission from Unicaf University, I am willing to forward the research report upon completion of the study. I am looking forward to your favourable response.

Please, respond by completing the informed concent form on the last page of this letter and return a signed copy to Abel Wilson Magongo to the email: awmagongo@gmail.com

Kind regards,

Abel Wilson Magongo
Cellphone: +27728782329

INFORMATION:
Student Name: Abel Wilson Magongo
Email Address: awmagongo@gmail.com
School of Doctoral Studies
Unicaf University
Telephone: +2348034592046
Email: m.olanrewaju@unicaf.org

A consent form for the school principal

Dear Mr Magongo

I,_____, the principal of [**Name of IBDP School**], acknowledge the receipt of your letter that explains the purpose of your proposed research, which is entitled: **Comparative Study of School-Related Resources as Determinants of Mathematics Achievement Among International Baccalaureate Diploma Learners in South Africa and Singapore**. I, therefore, **consent/ do not consent** to the participation of my school in your research.

Principal signature :_____Date:_____

Researcher's signature: _ Date:25 January 2022

Appendix J: Gatekeeper Letter

UNICAF UNIVERSITY

UU_GL - Version 2.0

Gatekeeper letter

Address: Address of School

Date: 08-Dec-2021

Subject: IBDP Mathematics Analysis and Approaches

Dear Mr/s Wilson,

I am a doctoral student at Unicaf University Zambia. As part of my degree, I am carrying out a study on Comparative Study of School-Related Resources as Determinants of Mathematics Achievement Among International Baccalaureate Diploma Learners in South Africa and Singapore. My research study is based on IBDP 2 learners doing IBDP Mathematics Analysis and Approaches courses (Standard Level and Higher Level) for 2022 IBDP Mathematics AA external examinations. Your learners are recruited because all learners doing IBDP Mathematics AA in a sampled school are eligible to participate. Your school has been selected to participate through a systematic random sampling method from IBDP Schools in South Africa and Singapore.

I am writing to inquire whether you would be willing to assist me with permission to recruit learners participating in this research. Subject to approval by Unicaf Research Ethics Committee (UREC), this study will only use an online questionnaire to learners who agreed to participate in the study. South Africa has been trying to solve its problems in its education system for over 20 years now, with no success. The results of this study will inform South African policymakers, education reformers, teachers, principals, parents, and other stakeholders about necessary interventions needed to improve the South African Mathematics achievement to match that of South Africa's international counterpart. You will send, through emails, informed consent forms to learners who are 18 years or older. You will also send guardian consent forms to parents or guardians of learners under 18 years. You will then email me (awmagongo@gmail.com) school email accounts of all learners who agreed to participate in the study. This research project is titled "Comparative Study of School-Related Resources as Determinants of Mathematics Achievement Among International Baccalaureate Diploma Learners in South Africa and Singapore". The Project Supervisor is Dr K. O. Muraina, School of Doctoral Studies, Unicaf University, email: m.olanrewaju@unicaf.org.

Data collection will start from 1 February 2022 to 31 March 2022. The data will be collected through a questionnaire that will be sent online only. There will be no in-person contact with participants due to covid-19 protocols. Thank you in advance for your time and your

consideration of this project. Kindly please let me know if you require any further information or need any further clarifications.

Yours Sincerely,

Abel Wilson Magongo
Student's Name: Abel Wilson Magongo
Student's E-mail: awmagongo@gmail.com
29 Royland Crescent, Hout Bay, Cape Town Tel.: +27728782329 Dr K. O. Muraina
Lecturer in the School of Doctoral Studies, Unicaf University

Student's Address and Telephone:

Supervisor's **Title and** Name:
Supervisor's Position:
Supervisor's E-mail: m.olanrewaju@unicaf.org.

Appendix K: Guardian Informed Consent Form

2 1

UU_GIC - Version .

Guardian Informed Consent Form

Part 1: Debriefing of Participants

Student's Name: Abel Wilson Magongo

Student's E-mail Address: awmagongo@gmail.com

Student ID #: R1809D6356125

Supervisor's Name: Dr Muraina Kamilu Olanrewaju

University Campus: Unicaf University Zambia (UUZ)

Program of Study: Doctorate of Education (EdD)

Research Project Title: Comparative Study of School-Related Resources as Determinants of Mathematics Achievement Among International Baccalaureate Diploma Learners in South Africa and Singapore

Date: 14-Nov-2021

Provide a short description (purpose, aim and significance) of the research project, and explain why and how you have chosen this person to participate in this research
(maximum 150 words).

South Africa has been trying to solve its problems in its education system for over 20 years now, with no success. The results of this study will inform South African policymakers, education reformers, teachers, principals, parents, and other stakeholders about necessary interventions needed to improve the South African Mathematics achievement to match that of South Africa's international counterpart.

The stakeholders in South Africa should know if the problem is with the South African school-related resources, the South African national Mathematics curriculum, or the pedagogical approach (practice) to Mathematics.
This study will point at areas that need reform in the South African Mathematics curriculum. In addition, it will inform policymakers to where should be best spent in South African

, Abel Wilson Magongo , ensure that all Information stated above and that all co t all conditions have been met.

Student's Sig

The above namedis committed in ensuring participant's voluntarily participation in the research project and guaranteeing there are no potential risks and/or harms to the participants.

Student

Participants have the right to withdraw at any stage (prior or post the completion) of the research without any consequences and without providing any explanation. In these cases, data collected will be deleted.

All data and information collected will be coded and will not be accessible to anyone outside this research. Data described and included in dissemination activities will only refer to coded information ensuring beyond the bounds of possibility participant identification.

2 1

UU_G IC - Version .

Guardian Informed Consent Form

Part 2: Certificate of Consent

This section is mandatory and should to be signed by the participant's legal guardian

Student's Name: Abel Wilson Magongo

Student's E-mail Address: awmagongo@gmail.com

Student ID #: R1809D6356125

Supervisor's Name: Dr Muraina Kamilu Olanrewaju University **Campus**: Unicaf University Zambia (UUZ)

Program of Study: Doctorate of Education (EdD)

Research Project Title: Comparative Study of School-Related Resources as Determinants of Mathematics Achievement Among International Baccalaureate Diploma Learners in South Africa and Singapore

I have read the foregoing information about this study, or it has been read to me. I have had the opportunity to ask questions and discuss about it. I have received satisfactory answers to all my questions and I have received enough information about this study. I understand that the participant is free to withdraw from this study at any time without giving a reason for withdrawing and without negative consequences. I consent to the use of multimedia (e.g. audio recordings, video recordings) for the purposes of the participation to this study. I understand that all data will remain anonymous and confidential, unless stated otherwise.

I, _____, the legal guardian of _____ allow and provide consent that _____ can willingly participate in the study.

I, _____, the legal guardian of _____ have been ensured that verbal consent given by _____ will also be taken before the study.

Appendix L: Informed Consent Form for Participants

Informed Consent Form

Part 1: Debriefing of Participants

Student's Name: Abel Wilson Magongo

Student's E-mail Address: awmagongo@gmail.com

Student ID #: R1809D6356125

Supervisor's Name: Dr Muraina Kamilu Olanrewaju University

Campus: Unicaf University Zambia (UUZ)

Program of Study: Doctorate of Education (EdD)

Research Project Title: Comparative Study of School-Related Resources as Determinants of Mathematics Achievement Among International Baccalaureate Diploma Learners in South Africa and Singapore

Date: 14-Nov-2021

Provide a short description (purpose, aim and significance) of the research project, and explain why and how you have chosen this person to participate in this research (max Imum150 words).

South Africa has been trying to solve its problems in its education system for over 20 years now, with no success. The results of this study will inform South African policymakers, education reformers, teachers, principals, parents, and other stakeholders about necessary interventions needed to improve the South African Mathematics achievement to match that of South Africa's international counterpart. The stakeholders in South Africa should know if the problem is with the South African school-related resources, the South African national Mathematics curriculum, or the pedagogical approach (practice) to Mathematics.

This study will point at areas that need reform in the South African Mathematics curriculum. In addition, it will inform policymakers as to where money should be best spent in South African Mathematics education.

The above named Student is committed in ensuring participant's voluntarily participation in the research project and guaranteeing there are no potential risks and/or harms to the participants.

Participants have the right to withdraw at any stage (prior or post the completion) of the research without any consequences and without providing any explanation. In these cases, data collected will be deleted.

All data and information collected will be coded and will not be accessible to anyone outside this research. Data described and included in dissemination activities will only refer to coded information ensuring beyond the bounds of possibility participant identification.

, Abel Wilson Magongo , ensure that all information stated above is true and that been

Student's

1

2 1

UU IC - Version .

Informed Consent Form

Part 2: Certificate of Consent

This section is mandatory and should to be signed by the participant(s)

Student's Name: Abel Wilson Magongo

Student's E-mail Address: awmagongo@gmail.com

Student ID #: R1809D6356125

Supervisor's Name: Dr Muraina Kamilu Olanrewaju

University Campus: Unicaf University Zambia (UUZ)

Program of Study: Doctorate of Education (EdD)

Research Project Title: Comparative Study of School-Related Resources as Determinants of Mathematics Achievement Among International Baccalaureate Diploma Learners in South Africa and Singapore

I have read the foregoing information about this study, or it has been read to me. I have had the opportunity to ask questions and discuss about it. I have received satisfactory answers to all my questions and I have received

enough information about this study. I understand that I am free to withdraw from this study at any time without giving a reason for withdrawing and without negative consequences. I consent to the use of multimedia (e.g. audio recordings, video recordings) for the purposes of my participation to this study. I understand that my data will remain anonymous and confidential, unless stated otherwise. I consent voluntarily to be a participant in this study.

Participant's Print name:

Participant's Signature:

Date:

If the Participant Is Illiterate:

I have witnessed the accurate reading of the consent form to the potential participant, and the individual has had an opportunity to ask questions. I confirm that the aforementioned individual has given consent freely.

Witness's Print name:

Witness's Signature:

Date:

Appendix M: Research Instrument (Questionnaire)

Comparative Study of School-RelatedResources as Determinants of Mathematics Achievement Among International Baccalaureate Diploma Learners in South Africa and Singapore

A project being conducted in South Africa and Singapore by a Doctorate of Education (EdD) student at Unicaf University

INFORMATION FOR VOLUNTEER PARTICIPANTS

Student Name: Abel Wilson Magongo Email Address: awmagongo@gmail.com

School of Doctoral Studies

Unicaf University

Telephone: +2348034592046

Email: m.olanrewaju@unicaf.org

Welcome to my survey. Thank you for participating in my survey. Your feedback is essential.

This survey investigates if school-related resources are determinants of Mathematics achievement among International Baccalaureate Diploma Learners in South Africa and Singapore. The survey participation should not take any longer than 25 - 30 minutes.

If you agree to participate, you will also be asked to answer questions about your school- related resources' availability, accessibility, and utilisation.

You do not put your name or any other identifying information on this questionnaire, so your responses will remain confidential. Furthermore, the report of this project will not refer to any person's responses, only the overall group responses and only in terms of how well these measures seem to work.

By participating in this exercise, you will be contributing to the teaching and learning of Mathematics. There are no risks anticipated in participating in this study. However, if you do experience distress, you may wish to contact a counsellor at Lifeline at +2348034592046.

This service may be contacted without the need for prior or special approval.

Participation is entirely voluntary. If you choose not to participate, no penalty will be incurred or loss of any benefits otherwise entitled to you. You may withdraw your participation at any time, without penalty, and will not be required to explain your actions.

If you have concerns or require further information regarding the exercise and its purpose in getting information on the learning of Mathematics, please get in touch with the project.

Supervisor, Dr. K. O. Muraina, School of Doctoral Studies, Unicaf University, Telephone: +2348034592046 or email: m.olanrewaju@unicaf.org. Thank you for your assistance in the learning activity. Completing and submitting the questionnaire to the learner will be deemed to consent to your participation in this exercise. If you wish, please copy and retain this cover sheet for your reference.

Please check the first square to confirm that you agree to participate and understandthat this survey is completely anonymous. *[Mark only one square]*

☐ I agree to participate and understand that this survey is completely anonymous.

☐ I choose not to participate and will immediately alert a staff member.

Section 1: Demographic Information

1. Are you female or male? Female ☐ Male ☐

2. In which country is your school located? South Africa ☐ Singapore ☐

3. When were you born? (Select the circle with the corresponding month and year you wereborn.)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Othe r
January	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
February	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
March	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
April	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
May	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
June	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
July	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
August	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
September	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
October	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
November	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
December	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

4. Enter your email _____

5. All students are treated the same, regardless of whether their parents are rich or poor.
(Mark only one square)

Strongly Agree	1	2	3	4	5	Strongly Disagree
	☐	☐	☐	☐	☐	

6. Putting them all together, what were your grades last year? (Mark only one square.)

Mostly 7s ☐ Mostly 6s ☐ Mostly 5s ☐ Mostly 4s ☐ Mostly 3s ☐ Mostly 2s ☐ Mostly 1s ☐

7. Do you feel your schoolwork is important? (Select one that best describes your situation).

Very important ☐ Quite important ☐ Fairly important ☐ Somewhat important ☐ Not important at all ☐

8. Boys and girls are treated equally well. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

Studying IBDP Mathematics AA

9. Which Mathematics course are you doing? (*Mark only one square*)	IBDP Mathematics AA SL IBDP ☐	Mathematics AA HL ☐

10. How much time do you spend in Mathematics class each week? [Write in the number of minutes per week. Please convert the number of classes/periods intominutes.] _____

11. How much time do you spend on mathematics outside of class each week? [Write in the number of minutes per week. Please convert the number of hours intominutes.] _____

12. A. During the school year, do you work at a paid job on a regular basis? (*Mark only one square*)	Yes ☐	No ☐

If Yes, B. How much time do you spend working at the paid job each week? [Write in the number of minutes per week. Please convert the number of hours into minutes.] _____

13. A. During the last 12 months, have you attended extra lessons or tutoring notprovided by the school in IBDP Mathematics AA? (*Mark only one square*)	Yes ☐	No ☐

If Yes, B. Why did you attend these extra lessons or tutoring? (*Mark only one square for each line*)

	Yes	No
(a) To excel in class	☐	☐
(b) To keep up in class	☐	☐
(c) To do well on an examination	☐	☐

C. For how many of the last 12 months have you attended extra lessons or tutoringin IBDP Mathematics AA?

Less than 4 months ☐ 4 – 8 months ☐ More than 8 months ☐

14. How much do you agree with these statements about your IBDP Mathematics AA lessons?

(a) The teacher clearly communicates the purpose of each Mathematics lesson. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

(b) I know what my teacher expects me to do. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

(c) My teacher is easy to understand. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

(d) I am interested in what my teacher says. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

(e) My teacher gives me interesting things to do. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

(f) My teacher asks me thought-provoking questions. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

(g) My teacher has clear answers to my questions. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

(h) My teacher links new content to what I already know. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

(i) My teacher is good at explaining IBDP Mathematics AA. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

(j) My teacher provides the opportunity for me to show what I have learned. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

(k) My teacher encourages me to keep working on IBDP mathematics AA problems until I solve them. (Mark only one square)

Strongly Agree 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Strongly Disagree

(l) My teacher provides helpful feedback on my schoolwork (including homework). (Mark only one square)

Strongly Agree 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Strongly Disagree

(m) My teacher uses a variety of teaching methods, tasks, and activities to help uslearn. (Mark only one square)

Strongly Agree 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Strongly Disagree

(n) My teacher believes that I can learn difficult IBDP Mathematics material. (Mark only one square)

Strongly Agree 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Strongly Disagree

(o) I like the way my teacher teaches Mathematics. (Mark only one square)

Strongly Agree 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Strongly Disagree

15. How much time do you spend in Mathematics class each week? (Add all the periods in minutes. _____

16. How much time do you spend on mathematics outside of class each week?(Time in minutes). _____

17. How much do you agree with these statements about the Mathematics you are studying?

(a) When I do Mathematics problems, I sometimes get completely absorbed. (Mark only one square)

Strongly Agree 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Strongly Disagree

(b) I get a sense of satisfaction when I solve Mathematics problems. (Mark only one square)

Strongly Agree 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Strongly Disagree

(c) I feel bored when I do my Mathematics schoolwork. (Mark only one square)

Strongly Agree	1	2	3	4	5	Strongly Disagree

(d) I like studying for my Mathematics class outside of school. (Mark only one square)

Strongly Agree	1	2	3	4	5	Strongly Disagree

(e) It is interesting to learn Mathematics theory. (Mark only one square)

Strongly Agree	1	2	3	4	5	Strongly Disagree

(f) I dread my Mathematics class. (Mark only one square)

Strongly Agree	1	2	3	4	5	Strongly Disagree

(g) I am studying Mathematics because I like to learn new things. (Mark only one square)

Strongly Agree	1	2	3	4	5	Strongly Disagree

(h) I enjoy figuring out challenging Mathematics. (Mark only one square)

Strongly Agree	1	2	3	4	5	Strongly Disagree

(i) Mathematics is one of my favourite subjects. (Mark only one square)

Strongly Agree	1	2	3	4	5	Strongly Disagree

(j) Jobs that require IBDP Mathematics AA skills seem interesting to me. (Mark only one square)

Strongly Agree	1	2	3	4	5	Strongly Disagree

(k) I wish I did not have to study mathematics. (Mark only one square)

Strongly Agree	1	2	3	4	5	Strongly Disagree

(l) I enjoy thinking about the world in terms of Mathematical relationships. (Mark only one square)

Strongly Agree	1	2	3	4	5	Strongly Disagree

18. What was your final score in previous academic year for IBDP Mathematics AA SL or Mathematics AA HL?

	0 to 9	10 to 19	20 to 29	30 to 39	40 to 49	50 to 59	60 to 69	70 to 79	80 to 89	90 to 99	100
Score in %											

19. How much do you agree with these statements about the mathematics you are studying?

(a) Learning mathematics will help me get ahead in the world. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

(b) It is important to do well in my Mathematics class. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

(c) The Mathematics I am studying is not useful for my future. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

(d) My parents are pleased that I am taking IBDP Mathematics AA. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

(e) Doing well in mathematics will help me get into the university of my choice. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

(f) Learning advanced Mathematics does not seem to be a worthwhile exercise. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

(g) My parents think that it is important that I do well in my Mathematics class. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

(h) I like telling people I am studying IBDP Mathematics AA. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

(i) Learning advanced Mathematics will give me more job opportunities. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

Section 2: Availability of school-related resources

	Yes	No
20. Does your school have a school library? (*Mark only one square*)	☐	☐
21. Does this school have a library media centre? (A library media centre is an organised collection of printed or audio-visual or computer resources which is administered as a unit, is located in a designated place or places, and makes resources and services available to students, teachers, and administrators. A library media centre may be called a school library, media centre, resource centre, information centre, instructional materials centre, learning resource centre,or any other similar name.) (*Mark only one square*)	☐	☐

22. Do you have any of these things? (*Mark only one square for each line.*)

	Yes	No
(a) Your own computer	☐	☐
(b) Your own tablet	☐	☐
(c) Your own smartphone	☐	☐
(d) Your own graphing calculator	☐	☐
(e) A gaming system (e.g., PlayStation®, Wii®, XBox®)	☐	☐
(f) Study desk/table for your use	☐	☐
(g) Your own room	☐	☐

23. When you are at school, do you have Internet to do any of the following tasks for Mathematics schoolwork (including classroom tasks, homework, and studying outside of class)?

(*Mark only one square for each line.*)	Yes	No
(a) Access the textbook or other course material	☐	☐
(b) Access assignments posted online by my teacher	☐	☐
(c) Collaborate with classmates on Mathematics assignments or projects	☐	☐
(d) Communicate with the teacher	☐	☐
(e) Discuss Mathematics topics with other students	☐	☐
(f) Find information, articles or tutorials to aid in understanding Mathematics concepts	☐	☐
(g) Find information, articles or tutorials to aid in solving Mathematics problems	☐	☐

24. Does your school have the following general school resources?

(*Mark only one square for each line.*)	Yes	No
(a) Instructional materials (e.g. textbooks)	☐	☐
(b) Supplies (e.g. papers, pencils, materials)	☐	☐
(c) Heating/cooling and lighting systems	☐	☐
(d) Instructional space (e.g. classrooms)	☐	☐
(e) Technological competent staff	☐	☐
(f) Audio-visual resources for delivery of instructions (e.g. interactive whiteboards, digital projectors)	☐	☐
(g) Computer technology for teaching and learning (e.g. computers or tablets for student use	☐	☐

25. Does your school have the following resources for IBDP Mathematics Analysis and Approaches?

(Mark only one square for each line.)

	Yes	No
(a) Teachers with specialisation in IBDP Mathematics AA	☐	☐
(b) Computer software/applications for IBDP Mathematics AA learning	☐	☐
(c) Library resources relevant to IBDP Mathematics AA learning	☐	☐
(d) Graphing Display Calculators for IBDP Mathematics AA learning	☐	☐

26. We have plenty of textbooks and other supplies for our lessons. (Select one that best describes your situation).

Not true at all ☐ Somewhat not true ☐ I am not sure ☐ Somewhat true ☐ Very true ☐

27. My class sizes are too large for me to learn well. (Select one that best describes your situation).

Not true at all ☐ Somewhat not true ☐ I am not sure ☐ Somewhat true ☐ Very true ☐

28. This school provides instructional materials (e.g., textbooks, hand-outs) that reflect my cultural background, ethnicity, and identity. (Mark only one square)

Strongly Agree 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Strongly Disagree

29. Teachers are available when I need to talk with them. (Mark only one square)

Strongly Agree 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Strongly Disagree

30. We don't learn much when a substitute teacher is in the classroom. (Select one that best describes your situation).

Not true at all ☐ Somewhat not true ☐ I am not sure ☐ Somewhat true ☐ Very true ☐

31. Students at this school steal money, electronics, or other valuable things while at school. (Mark only one square)

Strongly Agree 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Strongly Disagree

32. Students at this school damage or destroy other students' property. (Mark only one square)

Strongly Agree 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Strongly Disagree

33. The bathrooms in this school are clean. (Mark only one square)

Strongly Agree 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Strongly Disagree

34. The temperature in this school is comfortable all year round. (Mark only one square)

Strongly Agree 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Strongly Disagree

35. The school grounds are kept clean. (Mark only one square)

Strongly Agree	1	2	3	4	5	Strongly Disagree

36. I think that students are proud of how this school looks on the outside. (Mark only one square)

Strongly Agree	1	2	3	4	5	Strongly Disagree

37. Broken things at this school get fixed quickly. (Mark only one square)

Strongly Agree	1	2	3	4	5	Strongly Disagree

38. Are the following programmes or services currently available AT THIS SCHOOL fors learners in any of grades K-12 or comparable ungraded levels, regardless of funding source?

(Mark only one square for each line.)	Yes	No
(a) Before-school or after-school programme providing instruction beyond the normal school day for learners who need academic assistance	☐	☐
(b) Before-school or after-school programme providing instruction beyond the normal school day for learners who seek academic advancement or enrichment	☐	☐
(c) Before-school or after-school	☐	☐

39. LAST summer (2021) or LAST school year (2021), were summer school activities or academic intersessions provided for students enrolled in this school who needed ACADEMIC ASSISTANCE? *(Mark only one square)*	Yes ☐	No ☐

40. LAST summer (2011) or LAST school year (2010-11), were summer school activities or academic intersessions provided for students enrolled in this school who sought ACADEMIC ADVANCEMENT OR ENRICHMENT? *(Mark only one square)*	Yes ☐	No ☐

Section 3: Accessibility of school-related resources

41. Do you have access to your school library? *(Mark only one square)*

Yes	No	I don't have a school library
☐	☐	☐

42. When doing Mathematics at school, do you have access to any of these things?

(Mark only one square for each line.)	Yes	No
(a) A computer	☐	☐
(b) A tablet	☐	☐
(c) A smartphone	☐	☐
(d) Graphing Display Calculators (GDC)	☐	☐
(e) Study desk/table for your use	☐	☐

43. Do you have access to the following general school resources?

(Mark only one square for each line.)	Yes	No
(a) Instructional materials (e.g. textbooks)	☐	☐
(b) Supplies (e.g. papers, pencils, materials)	☐	☐
(c) Heating/cooling and lighting systems	☐	☐
(d) Instructional space (e.g. classrooms)	☐	☐
(e) Technological competent staff	☐	☐
(f) Audio-visual resources for delivery of instructions (e.g. interactive whiteboards, digital projectors)	☐	☐
(g) Computer technology for teaching and learning (e.g. computers or tablets for student use	☐	☐

44. Do you have access to the following general school resources?

(Mark only one square for each line.)	Yes	No
(a) Access the textbook or other course material	☐	☐
(b) Access assignments posted online by my teacher	☐	☐
(c) Collaborate with classmates on Mathematics assignments or projects	☐	☐
(d) Communicate with the teacher	☐	☐
(e) Discuss Mathematics topics with other students	☐	☐
(f) Find information, articles or tutorials to aid in solving Mathematics problems	☐	☐

45. Do you have access to the following resources for IBDP Mathematics Analysisand Approaches?

(Mark only one square for each line.)	Yes	No
(a) Teachers with specialisation in IBDP Mathematics AA	☐	☐
(b) Computer software/applications for IBDP Mathematics AA learning	☐	☐
(c) Library resources relevant to IBDP Mathematics AA learning	☐	☐
(d) Graphing Display Calculators for IBDP Mathematics AA learning	☐	☐

46. My teachers praise me when I work hard in school. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

47. My teachers give me individual attention when I need it. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

48. My teachers often connect what I am learning to life outside the classroom. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

49. The things I'm learning in school are important to me. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

50. My teachers expect me to do my best all the time. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

51. My teachers really care about me. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

52. I can talk to my teachers about problems I am having in class. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

53. I can talk to a teacher or other adult at this school about something that is bothering me. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

54. Adults working at this school reward students for positive behaviour. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

55. Discipline is fair. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

Section 4: Utilisation of school-related resources

56. Do you use your school library for Mathematics related work? *(Mark only one square)*

Yes	No	I don't have a school library
☐	☐	☐

57. When learning Mathematics at school, do you use any of these things?

(Mark only one square for each line.)	Yes	No
(a) A computer	☐	☐
(b) A tablet	☐	☐
(c) A smartphone	☐	☐
(d) Graphing Display Calculators (GDC)	☐	☐
(e) Study desk/table for your use	☐	☐

58. Do you use the Internet to do any of the following tasks for Mathematics schoolwork (including classroom tasks, homework, and studying outside of class)?

(Mark only one square for each line.)	Yes	No
(a) Access the textbook or other course material	☐	☐
(b) Access assignments posted online by my teacher	☐	☐
(c) Collaborate with classmates on Mathematics assignments or projects	☐	☐
(d) Communicate with the teacher	☐	☐
(e) Discuss Mathematics topics with other students	☐	☐
(f) Find information, articles or tutorials to aid in understanding Mathematics concepts	☐	☐
(g) Find information, articles or tutorials to aid in solving Mathematics problems	☐	☐

59. Do you use the following general school resources?

(Mark only one square for each line.)	Yes	No
(a) Instructional materials (e.g. textbooks)	☐	☐
(b) Supplies (e.g. papers, pencils, materials)	☐	☐
(c) Heating/cooling and lighting systems	☐	☐
(d) Instructional space (e.g. classrooms)	☐	☐
(e) Technological competent staff	☐	☐
(f) Audio-visual resources for delivery of instructions (e.g. interactive whiteboards, digital projectors)	☐	☐
(g) Computer technology for teaching and learning (e.g. computers or tablets for student use	☐	☐

60. Do you use the following resources for IBDP Mathematics Analysis andApproaches?

(Mark only one square for each line.)	Yes	No
(a) Teachers with specialisation in IBDP Mathematics AA	☐	☐
(b) Computer software/applications for IBDP Mathematics AA learning	☐	☐
(c) Library resources relevant to IBDP Mathematics AA learning	☐	☐
(d) Graphing Display Calculators for IBDP Mathematics AA learning	☐	☐

61. My teachers liked their job of teaching students. (Select one that best describes your situation).

Very important	Quite important	Fairly important	Somewhat important	Not important at all
☐	☐	☐	☐	☐

62. My teachers spend a lot of time helping students with their personal problems. (Select one that best describes your situation).

Very important	Quite important	Fairly important	Somewhat important	Not important at all
☐	☐	☐	☐	☐

63. My teachers tell me that I will be successful in the future. (Select one that best describes your situation).

Very important	Quite important	Fairly important	Somewhat important	Not important at all
☐	☐	☐	☐	☐

64. My teachers call my home to talk to my parents about how I'm doing at school. (Select one that best describes your situation).

Very important	Quite important	Fairly important	Somewhat important	Not important at all
☐	☐	☐	☐	☐

65. My teachers notice when I am doing a good job and let me know about it. (Select one that best describes your situation).

Very important	Quite important	Fairly important	Somewhat important	Not important at all
☐	☐	☐	☐	☐

66. Our teachers work together to plan classroom activities. (Select one that best describes your situation).

Very important	Quite important	Fairly important	Somewhat important	Not important at all
☐	☐	☐	☐	☐

67. Teachers talk to students like me about going to college. (Select one that best describes your situation).

Very important	Quite important	Fairly important	Somewhat important	Not important at all
☐	☐	☐	☐	☐

68. Teachers care about students in this school. (Select one that best describes your situation).

Very important	Quite important	Fairly important	Somewhat important	Not important at all
☐	☐	☐	☐	☐

69. Teachers make all students feel like they belong at school. (Select one that best describes your situation).

Very important	Quite important	Fairly important	Somewhat important	Not important at all
☐	☐	☐	☐	☐

70. Teachers treat students with respect. (Select one that best describes your situation).

Very important	Quite important	Fairly important	Somewhat important	Not important at all
☐	☐	☐	☐	☐

71. It is easy to talk with teachers at this school. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

72. My teachers care about me. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

73. My teachers make me feel good about myself. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

74. Students respect one another. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

75. Students like one another. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

76. If I am absent, there is a teacher or some other adult at school that will noticemy absence. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

77. I am happy to be at this school. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

Section 5: Last comment

78. If you have any other comments, please write below.

_____

_____

_____

_____

Appendix N: IEA Approval Letter for Using their Questionnaire Items

Number IEA-_____(to be filled by IEA) 22-060

PERMISSION REQUEST FORM

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Type of requested material (select all that apply):
☐ Assessment/test items ☐ Background questionnaires
☐ Text excerpt (e.g., chapter) ☐ Figure/table
☒ Other, please specify: TIMSS Context Questionnaire items (Student Questionnaire - Advanced Mathematics 2015)

Please indicate the source of the IEA material:
Author/editor: IEA
Title: TIMSS Student Questionnaire - Advanced Mathematics 2015 ISBN:
Date of publication: 2015 URL: https://timssandpirls.bc.edu/timss2015/advanced-questionnaires/downloads/TA15_StuQ_Math.pdf

Language of requested materials: English
Description of requested IEA material (please indicate item numbers, pages, etc.): Items 1, 2, 6, 13,14,15,16,17,18,19, 20, 21, and 22. (See my attached questionnaire with adapted items from TIMSS Student Questionnaire - Advanced Mathematics 2015)

NOTE: Please attach text or graphics from the IEA material you would like to use or reproduce.

1. How IEA material will be used

Information about your intended use (select all that apply):

☐ Non-commercial ☐ Commercial

☒ Thesis ☐ Publication (e.g., article, book)

☐ Data collection (sample size: _____ data collection window: ☐ _____)

Other, please specify: _____

Please provide sufficient information about your research project (e.g., research question, methodology, etc.):

Although TIMSS Advance was never ever conducted in the past in both South Africa and Singapore, the current study is not a replication nor a representation of the TIMSS Adavance studies. The conditions of data collection and methods of analysis under the current study are different from those of the TIMSS Advance studies. The current researcher will only infer the

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results of the current study, if need be, to some contextual results of other global studies (for example, TIMSS Advance 2015). The study will be conducted for the first time in both South Africa and Singapore in grade-12 and/or IBDP 2 learners. The current study would be carried on schools in Singapore that have been excluded (exclusion) from the global TIMSS study for all grades, since the inception of the TIMSS study in 1995 (the private schools in Singapore). These are schools offering the foreign curriculum (International Baccalaureate Diploma Programme). The focus of this study is on International Baccalaureate Diploma Programme (IBDP) 2 Learners

doing IBDP Mathematics AA course. Therefore, this study comparatively investigates school-related resources as determinants of Mathematics achievement among International Baccalaureate Diploma learners in South Africa and Singapore. These are schools which were excluded from TIMSS studies in Singapore, as Singapore was conducting the TIMSS study only on schools offering the local national curriculum, not foreign curriculum. The current study focuses on the excluded schools (private schools) which are under TIMSS exclusion. However, the South African IBDP schools were not excluded from the TIMSS study. There are 30 IBDP schools in Singapore (all were excluded from the TIMSS study) that form the population of my study, and three IBDP schools in South Africa. The current study focuses on schools offering the IBDP programme in both South Africa and Singapore.

The Purpose of the Study

The purpose of this correlational method research design study is to find:

1. The difference in the availability of school-related resources to IBDP 2 learners in South Africa and Singapore.
2. The difference in the accessibility of the school-related resources of IBDP 2 Learners in South Africa and Singapore.
3. The difference in the school-related resources utilisation of IBDP 2 Learners in South Africa and Singapore.
4. The difference in the Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore.
5. Relationship between school-related resources availability and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore.
6. Relationship between school-related resources accessibility and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore.
7. Relationship between school-related resources utilisation and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore.

The Aims of the Study

1. This study aims to comparatively investigate the difference in the school-related resources availability, accessibility, and utilisation and Mathematics achievement of IBDP 2 Learners in South Africa and Singapore.

2. This study aims to investigate the relationship among school-related resources availability, accessibility comparatively, and utilization compared to Mathematics achievement of IBDP 2 Learners in South Africa and Singapore.

Research questions:

1. What is the relationship between school-related resources availability and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore?

2. What is the relationship between school-related resources accessibility and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore?

3. What is the relationship between school-related resources utilisation and Mathematics Achievement of IBDP 2 Learners in South Africa and Singapore?

Methodology

The correlational method research design approach would be used in this research. This study will mainly use inferential statistics, quantitative data analysis. An Independent sample t-test will be used because we will be comparing two independent sample means. As for investigating the relationship between variables, the researcher will use correlation/regression statistical analysis.

Information about where the requested materials or research results will appear:

☐ Print publication ☐

☐ Online publication (e.g., online journal)

☒ Website (URL:_____)

Other, please specify: Doctoral dissertation report at Unicaf University

Additional information about the planned publication (if applicable): N/A
Author:
Title:
Publisher or sponsor:
Language of publication:
Intended audience:
Number of copies for distribution:
Retail price:
Release date:
Additional comments:

2. Requestor information

First name: Abel Wilson
Last name: Magongo
Name of institution or organization: Unicaf University
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Country: Greece
Phone: +357 24747500
Email: doctoral.studies-aa@unicaf.org

Signature:

Date of request: 15-04-2022

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Number IEA-_____(to be filled by IEA) 22-060

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Signature: Date: 20/07/2022

Name: Dirk Hastedt

Title: Executive Director

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[1] Cf. ECJ 16 July 2009, Case C-5/08 (Infopaq I).

Appendix O: PLOS ONE Team Approval to Use their Pictures

Gmail **abel magongo**

Request for a Permission to use Pictures

3 messages

abel magongo <awmagongo@gmail.com> Wed, May 12, 2021 at 5:38 PM
To: ukadmin@plos.org, plos@plos.org, kathkar@uow.edu.au

Dear PLOS ONE Team and Katharina E. Kariippanon,

Good day to you. I am Abel Wilson Magongo, a Doctorate of Education (EdD) student with Unicaf University. In my research dissertation, I intend to use your two beautiful pictures that illustrate traditional and non-traditional classrooms (see link of the pictures below).

https://doi.org/10.1371/journal.pone.0223607.g001
https://doi.org/10.1371/journal.pone.0223607.g002

The title of my dissertation is "Comparative Study of School-Related Resources as Determinants of Mathematics Achievement Among International Baccalaureate Diploma Learners in South Africa and Singapore".

I saw the pictures when I was reading your article Katharina. They fit well with my classroom space resources. I would appreciate it if I would be granted permission to use the pictures in my dissertation.

Kind regards,
Abel Wilson Magongo (South African)
Cell: +27728782329

Sender notified
M

PLOS <PLOS@plos.org> Thu, May 13, 2021 at 12:21 AM
To: abel magongo <awmagongo@gmail.com>, UK Admin <ukadmin@plos.org>, "kathkar@uow.edu.au" <kathkar@uow.edu.au>

Dear Abel,

Many thanks for your email. PLOS applies the Creative Commons Attribution (CC BY) license to articles and other works we publish. This means that under the open access license, anyone can reuse our articles in whole or in part for any purpose, for free, or even for commercial purposes, as long as the author is credited for their work. For more information, please see our Journal Page where we discuss Licenses and Copyright.

If you have any further queries on concerns, please feel free to email me.

Best wishes,

Stephanie Tran

Digital Marketing Assistant, Outreach

stran@plos.org | she, her

PLOS

Empowering researchers to transform science

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From: abel magongo <awmagongo@gmail.com>
Sent: Wednesday, May 12, 2021 8:38 AM

To: UK Admin <ukadmin@plos.org>; PLOS <PLOS@plos.org>; kathkar@uow.edu.au **Subject:** Request for a Permission to use Pictures

Dear PLOS ONE Team and Katharina E. Kariippanon,

Good day to you. I am Abel Wilson Magongo, a Doctorate of Education (EdD) student with Unicaf University. In my research dissertation, I intend to use your two beautiful pictures that illustrate traditional and non-traditional classrooms (see link of the pictures below).

https://doi.org/10.1371/journal.pone.0223607.g001

https://doi.org/10.1371/journal.pone.0223607.g002

The title of my dissertation is "Comparative Study of School-Related Resources as Determinants of Mathematics Achievement Among International Baccalaureate Diploma Learners in South Africa and Singapore".

I saw the pictures when I was reading your article Katharina. They fit well with my classroom space resources. I would appreciate it if I would be granted permission to use the pictures in my dissertation.

Kind regards,

Abel Wilson Magongo (South African)

Cell: +27728782329

To: PLOS <PLOS@plos.org>
Cc: ukadmin@plos.org, kathkar@uow.edu.au

Dear Stephanie,

Thank you very much Ms Tran. This is much appreciated.

Kind regards,
Abel Wilson Magongo

Sender notified

by Mailtrack

[Quoted text hidden]

Appendix P: Data from the Pilot Study

Rehearsal Study.csv

Appendix Q: Data from the Main Study

Main Study data file.csv

Appendix R: Descriptive Statistics from Data of the Main Study Presented in Tables

School-related resources availability and Mathematics Achievement

20. Does your school have a school library? (*Mark only one square)*	Yes ☐	No ☐

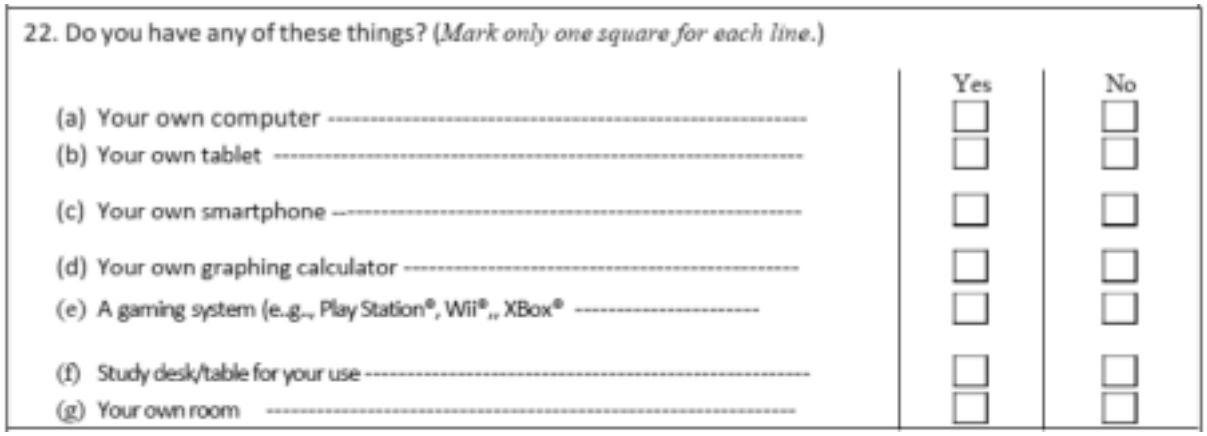
Does your school have a school library × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
Does your school have a school library	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

21. Does this school have a library media centre? (A library media centre is an organised collection of printed or audio-visual or computer resources which is administered as a unit, is located in a designated place or places, and makes resources and services available to students, teachers, and administrators.A library media centre may be called a school library, media centre, resource centre, information centre, instructional materials centre, learning resource centre,or any other similar name.) (*Mark only one square)*	Yes ☐	No ☐

Does this school have a library media center × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
Does this school have a library media center	No	Count	82	0	82
		Row %	100.0%	0.0%	100.0%
		Column %	92.1%	0.0%	48.5%
		Total %	48.5%	0.0%	48.5%
	Yes	Count	7	80	87
		Row %	8.0%	92.0%	100.0%
		Column %	7.9%	100.0%	51.5%
		Total %	4.1%	47.3%	51.5%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%


22. Do you have any of these things? (*Mark only one square for each line.*)

	Yes	No
(a) Your own computer	☐	☐
(b) Your own tablet	☐	☐
(c) Your own smartphone	☐	☐
(d) Your own graphing calculator	☐	☐
(e) A gaming system (e.g., Play Station®, Wii®,, XBox®	☐	☐
(f) Study desk/table for your use	☐	☐
(g) Your own room	☐	☐

Do you have your own computer × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
Do you have your own computer	No	Count	39	4	43
		Row %	90.7%	9.3%	100.0%
		Column %	43.8%	5.0%	25.4%
		Total %	23.1%	2.4%	25.4%

	Yes	Count	50	76	126
		Row %	39.7%	60.3%	100.0%
		Column %	56.2%	95.0%	74.6%
		Total %	29.6%	45.0%	74.6%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you have Your own tablet × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
Do you have Your own tablet	No	Count	63	8	71
		Row %	88.7%	11.3%	100.0%
		Column %	70.8%	10.0%	42.0%
		Total %	37.3%	4.7%	42.0%
	Yes	Count	26	72	98
		Row %	26.5%	73.5%	100.0%
		Column %	29.2%	90.0%	58.0%
		Total %	15.4%	42.6%	58.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you have Your own smartphone × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
Do you have Your own smartphone	No	Count	1	0	1
		Row %	100.0%	0.0%	100.0%
		Column %	1.1%	0.0%	0.6%
		Total %	0.6%	0.0%	0.6%

	Yes	Count	88	80	168
		Row %	52.4%	47.6%	100.0%
		Column %	98.9%	100.0%	99.4%
		Total %	52.1%	47.3%	99.4%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you have Your own graphing calculator × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
Do you have Your own graphing calculator	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you have A gaming system × In which country is your school located

			In which country is your school loca ted		Total
			South Africa	Singapore	
Do you have A gaming system	No	Count	57	36	93
		Row %	61.3%	38.7%	100.0%
		Column %	64.0%	45.0%	55.0%
		Total %	33.7%	21.3%	55.0%

	Yes	Count	32	44	76
		Row %	42.1%	57.9%	100.0%
		Column %	36.0%	55.0%	45.0%
		Total %	18.9%	26.0%	45.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

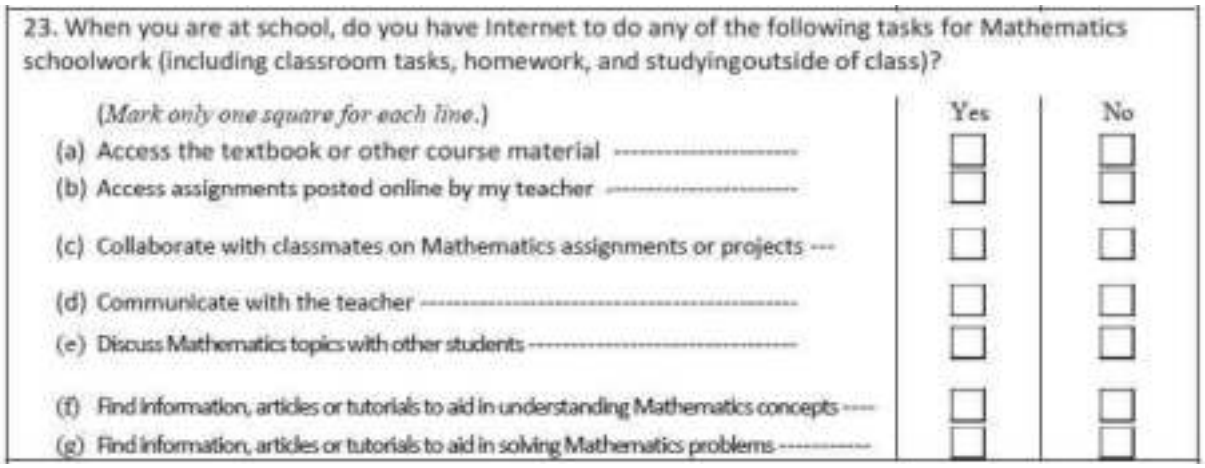
Do you have Study desk/table for your use × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
Do you have Study desk/table for your use	No	Count	2	0	2
		Row %	100.0%	0.0%	100.0%
		Column %	2.2%	0.0%	1.2%
		Total %	1.2%	0.0%	1.2%
	Yes	Count	87	80	167
		Row %	52.1%	47.9%	100.0%
		Column %	97.8%	100.0%	98.8%
		Total %	51.5%	47.3%	98.8%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you have Your own room × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
Do you have Your own room	No	Count	1	0	1

		Row %	100.0%	0.0%	100.0%
		Column %	1.1%	0.0%	0.6%
		Total %	0.6%	0.0%	0.6%
	Yes	Count	88	80	168
		Row %	52.4%	47.6%	100.0%
		Column %	98.9%	100.0%	99.4%
		Total %	52.1%	47.3%	99.4%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



23. When you are at school, do you have Internet to do any of the following tasks for Mathematics schoolwork (including classroom tasks, homework, and studyingoutside of class)?

(*Mark only one square for each line.*)

	Yes	No
(a) Access the textbook or other course material	☐	☐
(b) Access assignments posted online by my teacher	☐	☐
(c) Collaborate with classmates on Mathematics assignments or projects	☐	☐
(d) Communicate with the teacher	☐	☐
(e) Discuss Mathematics topics with other students	☐	☐
(f) Find information, articles or tutorials to aid in understanding Mathematics concepts	☐	☐
(g) Find information, articles or tutorials to aid in solving Mathematics problems	☐	☐

When you are at school, do you have Internet to do any of the following tasks for Mathematics schoolwork Access the textbook or other course material × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
When you are at school, do you have Internet to do any of the following tasks for Mathematics schoolwork Access the textbook or other course material	Yes	count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%

		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

When you are at school, do you have Internet to do any of the following tasks for Mathematics schoolwork Access assignments posted online by my teacher × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
When you are at school, do you have Internet to do any of the following tasks for Mathematics schoolwork Access assignments posted online by my teacher	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

When you are at school, do you have Internet to do any of the following tasks for Mathematics schoolwork Collaborate with classmates on Mathematics assignments or projects × In which country is your school located

			In which country school located	
			South Africa	Singap
When you are at school, do you have Internet to do any of the following tasks for Mathematics schoolwork Collaborate with classmates on Mathematics assignments or projects	Yes	Count	89	80
		Row %	52.7%	
		Column %	100.0%	47.3%
				100
		Total %	52.7%	
Total		Count	89	
		Row %	52.7%	
		Column %	100.0%	
		Total %	52.7%	

When you are at school, do you have Internet to do any of the following tasks for Mathematics schoolwork Communicate with the teacher × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
When you are at school, do you have Internet to do any of the following tasks for Mathematics schoolwork Communicate with the teacher	Yes	Count	89	80	169
		Row %	52.7%		100.0%
		Column %	100.0%	47.3%	100.0%
				100.0%	
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

When you are at school, do you have Internet to do any of the following tasks for Mathematics schoolwork Discuss mathematics topics with other students × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
When you are at school, do you have Internet to do any of the following tasks for Mathematics schoolwork Discuss mathematics topics with other students	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

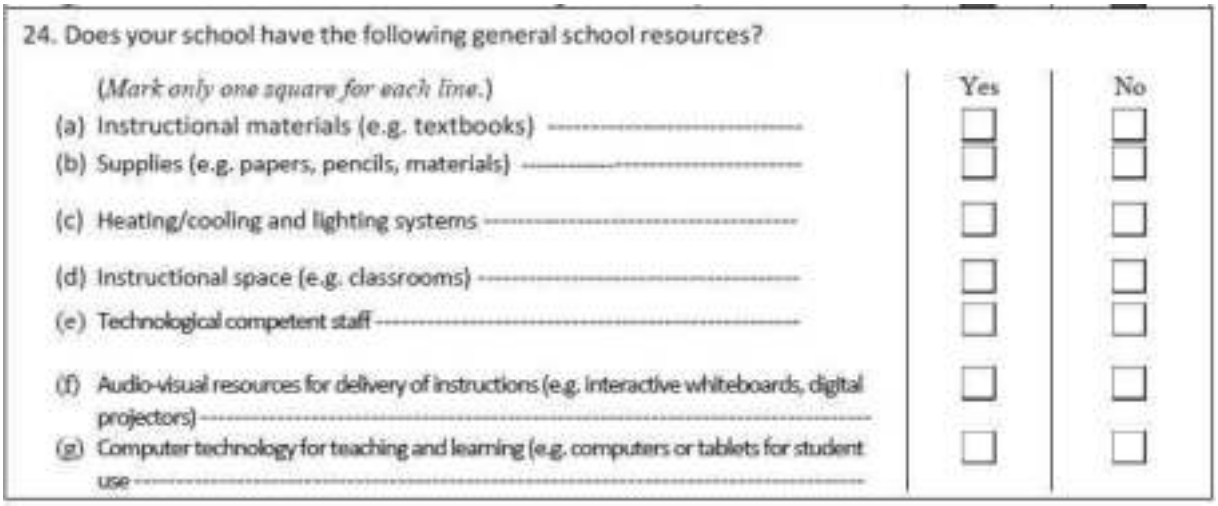
When you are at school, do you have Internet to do any of the following tasks for Mathematics schoolwork Find information, articles, or tutorials to aid in understanding Mathematics concepts × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
When you are at school, do you have Internet to do any of the	Yes	Count	89	80	169

following tasks for Mathematics schoolwork Find information, articles, or tutorials to aid in understanding Mathematics concepts		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

When you are at school, do you have Internet to do any of the following tasks for Mathematics schoolwork Find information, articles, or tutorials to aid in solving mathematics problems × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
When you are at school, do you have Internet to do any of the	Yes	Count	89	80	169
following tasks for Mathematics schoolwork Find information, articles, or tutorials to aid in solving mathematics problems		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



24. Does your school have the following general school resources?

(*Mark only one square for each line.*)

	Yes	No
(a) Instructional materials (e.g. textbooks)	☐	☐
(b) Supplies (e.g. papers, pencils, materials)	☐	☐
(c) Heating/cooling and lighting systems	☐	☐
(d) Instructional space (e.g. classrooms)	☐	☐
(e) Technological competent staff	☐	☐
(f) Audio-visual resources for delivery of instructions (e.g. interactive whiteboards, digital projectors)	☐	☐
(g) Computer technology for teaching and learning (e.g. computers or tablets for student use	☐	☐

Does your school have Instructional materials (e.g., textbooks) × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Does your school have Instructional materials (e.g., textbooks)	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169

	Row %	52.7%	47.3%	100.0%
Column %		100.0%	100.0%	100.0%
	Total %	52.7%	47.3%	100.0%

Does your school have Supplies (e.g., papers, pencils, materials) × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Does your school have Supplies (e.g., papers, pencils, materials)	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
	Total	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Does your school have Heating/cooling and lighting systems × In which country is your school located

			In which country is your school located	
			South Africa	Singapore
Does your school have Heating/cooling and lighting systems	No	Count	1	0
		Row %	100.0%	0.0%
		Column %	1.1%	0.0%
		Total %	0.6%	0.0%
	Yes	Count	88	80
		Row %	52.4%	47.6%
		Column %	98.9%	100.0%
		Total %	52.1%	47.3%
Total		Count	89	80
		Row %	52.7%	47.3%
		Column %	100.0%	100.0%
		Total %	52.7%	47.3%

Does your school have Instructional space (e.g., classrooms) × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Does your school have Instructional space (e.g., classrooms)	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%

Total	Count	89	80	169
	Row %	52.7%	47.3%	100.0%
	Column %	100.0%	100.0%	100.0%
	Total %	52.7%	47.3%	100.0%

Does your school have Technologically competent sta??? × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Does your school have Technologically competent staff	No	Count	1	0	1
		Row %	100.0%	0.0%	100.0%
		Column %	1.1%	0.0%	0.6%
		Total %	0.6%	0.0%	0.6%
	Yes	Count	88	80	168
		Row %	52.4%	47.6%	100.0%
		Column %	98.9%	100.0%	99.4%
		Total %	52.1%	47.3%	99.4%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Does your school have Audio-visual resources for delivery of instruction (e.g., interactive white boards, digital projectors) × In which country is your school located

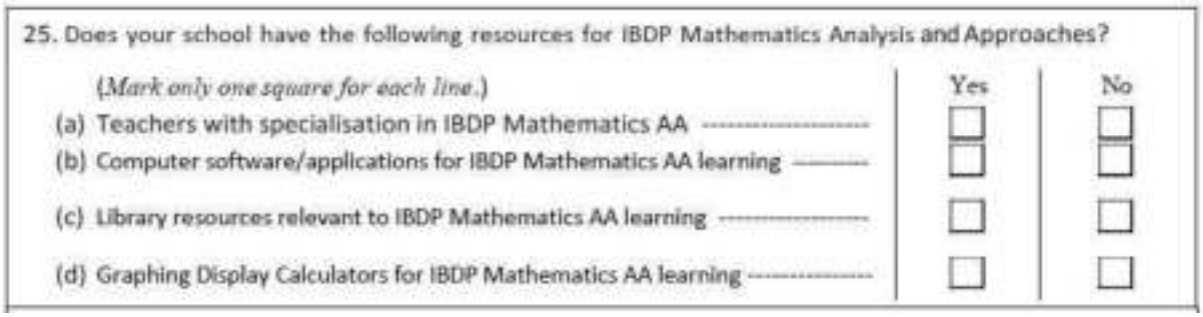
			In which country is your school located		
			South Africa	Singapore	Total
Does your school have Audio-visual resources for delivery of instruction (e.g., interactive white boards, digital projectors)	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%

Column %	100.0%	100.0%	100.0%

		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Does your school have Computer technology for teaching and learning (e.g., computers or tablets for student use) × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Does your school have Computer technology for teaching and learning (e.g., computers or tablets for student use)	No	Count	65	5	70
		Row %	92.9%	7.1%	100.0%
		Column %	73.0%	6.3%	41.4%
		Total %	38.5%	3.0%	41.4%
	Yes	Count	24	75	99
		Row %	24.2%	75.8%	100.0%
		Column %	27.0%	93.8%	58.6%
		Total %	14.2%	44.4%	58.6%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



25. Does your school have the following resources for IBDP Mathematics Analysis and Approaches?

(*Mark only one square for each line.*)

	Yes	No
(a) Teachers with specialisation in IBDP Mathematics AA	☐	☐
(b) Computer software/applications for IBDP Mathematics AA learning	☐	☐
(c) Library resources relevant to IBDP Mathematics AA learning	☐	☐
(d) Graphing Display Calculators for IBDP Mathematics AA learning	☐	☐

Does your school have Teachers with a specialization in IBDP Mathematics AA × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Does your school have Teachers with a specialization in IBDP Mathematics AA	No	Count	1	0	1
		Row %	100.0%	0.0%	100.0%
		Column %	1.1%	0.0%	0.6%
		Total %	0.6%	0.0%	0.6%
	Yes	Count	88	80	168
		Row %	52.4%	47.6%	100.0%
		Column %	98.9%	100.0%	99.4%
		Total %	52.1%	47.3%	99.4%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Does your school have Computer software/applications for IBDP Mathematics AA learning × In which country is your school located

Does your school have Computer software/applications for IBDP Mathematics AA learning	No	Count		R
		Column		

				%	
				Total %	
		Yes	Count		R
			Column %		
			Total %		
Total			Count		
			Row %		
			Column %		
			Total %		

Does your school have Library resources relevant to IBDP Mathematics AA learning × In which country is your school located

				In which country is your school located		
				South Africa	Singapore	Total
Does your school have Library resources relevant to IBDP Mathematics AA learning	No	Count		78	0	78
		Row %		100.0%	0.0%	100.0%
		Column %		87.6%	0.0%	46.2%
		Total %		46.2%	0.0%	46.2%
	Yes	Count		11	80	91
		Row %		12.1%	87.9%	100.0%
		Column %		12.4%	100.0%	53.8%
		Total %		6.5%	47.3%	53.8%
Total		Count		89	80	169
		Row %		52.7%	47.3%	100.0%
		Column %		100.0%	100.0%	100.0%
		Total %		52.7%	47.3%	100.0%

Does your school have Graphing Display Calculators for IBDP Mathematics AA learning × In which country is your school located

				In which country is your school located		
				South Africa	Singapore	Total
Does your school have Graphing Display Calculators for IBDP Mathematics learning	Yes	Count		89	80	169
	AA	Row %		52.7%	47.3%	100.0%
		Column %		100.0%	100.0%	100.0%
		Total %		52.7%	47.3%	100.0%
Total		Count		89	80	169
		Row %		52.7%	47.3%	100.0%
		Column %		100.0%	100.0%	100.0%
		Total %		52.7%	47.3%	100.0%

26. We have plenty of textbooks and other supplies for our lessons. (Select one that best describes your situation).

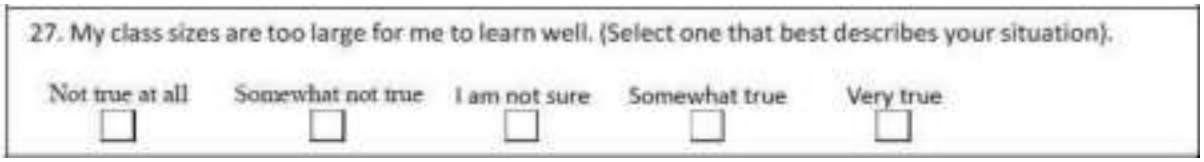
Not true at all ☐ Somewhat not true ☐ I am not sure ☐ Somewhat true ☐ Very true ☐

We have plenty of textbooks and other supplies for our lessons × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
We have plenty of textbooks and other supplies for our lessons.	Not true at all	Count	1	0	1
		Row %	100.0%	0.0%	100.0%
		Column %	1.1%	0.0%	0.6%
		Total %	0.6%	0.0%	0.6%
	I am not sure	Count	5	0	5
		Row %	100.0%	0.0%	100.0%
		Column %	5.6%	0.0%	3.0%

Total %	3.0%	0.0%	3.0%

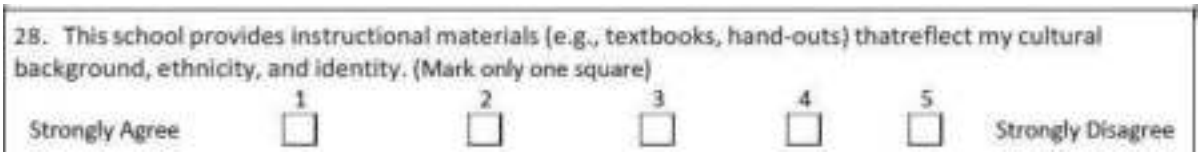
	Some what true	Count	4	2	6
		Row %	66.7%	33.3%	100.0%
		Column %	4.5%	2.5%	3.6%
		Total %	2.4%	1.2%	3.6%
	Very true	Count	79	78	157
		Row %	50.3%	49.7%	100.0%
		Column %	88.8%	97.5%	92.9%
		Total %	46.7%	46.2%	92.9%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



My class sizes are too large for me to learn well × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
My class sizes are too large for me to learn well	Not true at all	Count	7	18	25
		Row %	28.0%	72.0%	100.0%
		Column %	7.9%	22.5%	14.8%
		Total %	4.1%	10.7%	14.8%
	Some what not true	Count	22	53	75
		Row %	29.3%	70.7%	100.0%
		Column %	24.7%	66.3%	44.4%
		Total %	13.0%	31.4%	44.4%
	Not sure	Count	10	9	19
		Row %	52.6%	47.4%	100.0%
		Column %	11.2%	11.3%	11.2%
		Total %	5.9%	5.3%	11.2%
			34	0	34

	Some what true	Count	100.0%	0.0%	100.0%
		Row %	38.2%	0.0%	20.1%
		Column %	20.1%	0.0%	20.1%
		Total %			
	Very true	Count	16	0	16
		Row %	100.0%	0.0%	100.0%
		Column %	18.0%	0.0%	9.5%
		Total %	9.5%	0.0%	9.5%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



This school provides instructional materials (e.g., textbooks, handouts) that reflect my cultural background, ethnicity, and identity × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
This school provides instructional materials (e.g., textbooks, handouts) that reflect my cultural background, ethnicity, and identity	Strongly Agree	Count	25	49	74
		Row %	33.8%	66.2%	100.0%
		Column %	28.1%	61.3%	43.8%
		Total %	14.8%	29.0%	43.8%
	Agree	Count	42	31	73
		Row %	57.5%	42.5%	100.0%
		Column %	47.2%	38.8%	43.2%
		Total %	24.9%	18.3%	43.2%
	Not sure		7	0	7

		Count	100.0%	0.0%	100.0%
		Row %	7.9%	0.0%	4.1%
		Column %	4.1%	0.0%	4.1%
		Total %			
	Disagree	Count	7	0	7
		Row %	100.0%	.0%	100.0%
		Column %	7.9%	.0%	4.1%
		Total %	4.1%	0.0%	4.1%
	Strongly Disagree	Count	8	0	8
		Row %	100.0%	0.0%	100.0%
		Column %	9.0%	0.0%	4.7%
		Total %	4.7%	0.0%	4.7%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

29. Teachers are available when I need to talk with them. (Mark only one square)

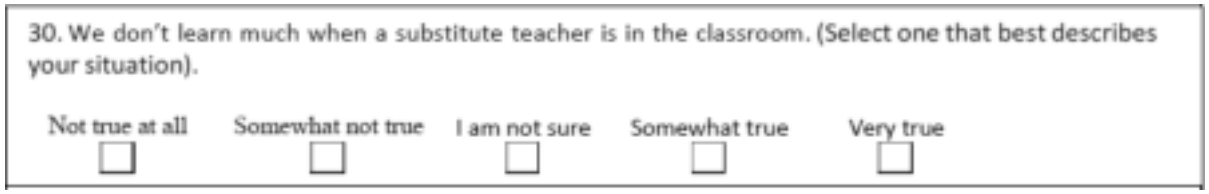
Strongly Agree	1	2	3	4	5	Strongly Disagree
	☐	☐	☐	☐	☐	

Teachers are available when I need to talk with them × In which country is your school located

				In which country is your school located	
				South Africa	Singapore
Teachers are available when I need to talk with them	Strongly Agree	Count		19	7
		Row %		0	
		Column %		21.3%	78.7%
		Total %		21.3%	87.5%
				11.2%	41.4%
	Agree	Count		36	1
		Row %		0	
		Column %		78.3%	21.7%
		Total %		40.4%	
				12.5%	
				21.3%	5.9%
	Not sure	Count		30	

0	Row %	100.0%	0.0%
	Column %	33.7%	0.0%
	Total %	17.8%	0.0%

Disagree	Count		2	0
	Row %		100.0%	0.0%
	Column %		2.2%	
	Total %		1.2%	
				0.0
			%	
Strongly Disagree	Count		2	0
	Row %		100.0%	0.0
			%	
	Column %		2.2%	
	Total %		1.2%	
				0.0
			%	
Total	Count		89	8
				0
	Row %			
	Column %			
	Total %			
	Row	%	52.7%	47.3%
	Column	%	100.0%	100.0%
	Total	%	52.7%	47.3%

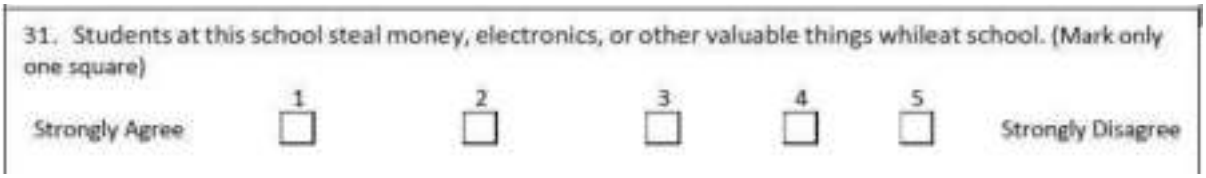


We don't learn much when a substitute teacher is in the classroom × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
We don't learn much when a substitute teacher is in the classroom	Not true at all	Count	2	11	13
		Row %	15.4%	84.6%	100.0%
		Column %	2.2%	13.8%	7.7%
		Total %	1.2%	6.5%	7.7%
	Somewhat not true	Count	12	57	69
		Row %	17.4%	82.6%	100.0%
		Column %	13.5%	71.3%	40.8%

	Total %	7.1%	33.7%	40.8%
I am not sure	Count	43	11	54
	Row %	79.6%	20.4%	100.0%
	Column %	48.3%	13.8%	32.0%
	Total %	25.4%	6.5%	32.0%
		23	1	24

	Somewhat true	Count	95.8%	4.2%	100.0%
		Row %	25.8%	1.3%	14.2%
		Column %	13.6%	0.6%	14.2%
		Total %			
	Very true	Count	9	0	9
		Row %	100.0%	0.0%	100.0%
		Column %	10.1%	0.0%	5.3%
		Total %	5.3%	0.0%	5.3%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



Students at this school steal money, electronics, or other valuable things while at school × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Students at this school steal money, electronics, or other valuable things while at school	Strongly agree	Count	1	2	3
		Row %	33.3%	66.7%	100.0%
		Column %	1.1%	2.5%	1.8%
		Total %	0.6%	1.2%	1.8%
	Agree	Count	16	1	17
		Row %	94.1%	5.9%	100.0%
		Column %	18.0%	1.3%	10.1%
		Total %	9.5%	0.6%	10.1%
	Not sure	Count	22	0	22
		Row %	100.0%	0.0%	100.0%
		Column %	24.7%	0.0%	13.0%
		Total %	13.0%	0.0%	13.0%

Disagree	Count	25	7	32
	Row %	78.1%	21.9%	100.0%

		Column %	28.1%	8.8%	18.9%
		Total %	14.8%	4.1%	18.9%
	Strongly disagree	Count	25	70	95
		Row %	26.3%	73.7%	100.0%
		Column %	28.1%	87.5%	56.2%
		Total %	14.8%	41.4%	56.2%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

32. Students at this school damage or destroy other students' property. (Mark only one square)

Strongly Agree	1	2	3	4	5	Strongly Disagree
	☐	☐	☐	☐	☐	

Students at this school damage or destroy other students' property × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Students at this school damage or destroy other students' property	Strongly agree	Count	1	1	2
		Row %	50.0%	50.0%	100.0%
		Column %	1.1%	1.3%	1.2%
		Total %	0.6%	0.6%	1.2%
	Agree	Count	17	2	19
		Row %	89.5%	10.5%	100.0%
		Column %	19.1%	2.5%	11.2%
		Total %	10.1%	1.2%	11.2%
	Not sure	Count	22	0	22
		Row %	100.0%	0.0%	100.0%
		Column	24.7%	0.0%	13.0%

		% Total %	13.0%	0.0%	13.0%
	Disagree	Count	30	10	40
		Row %	75.0%	25.0%	100.0%
		Column %	33.7%	12.5%	23.7%
		Total %	17.8%	5.9%	23.7%
	Strongly disagree	Count	19	67	86
		Row %	22.1%	77.9%	100.0%
		Column %	21.3%	83.8%	50.9%
		Total %	11.2%	39.6%	50.9%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

33. The bathrooms in this school are clean. (Mark only one square)

Strongly Agree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Disagree

The bathrooms in this school are clean × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
The bathrooms in this school are clean	Strongly agree	Count	3	15	18
		Row %	16.7%	83.3%	100.0%
		Column %	3.4%	18.8%	10.7%
		Total %	1.8%	8.9%	10.7%
	Agree	Count	30	61	91
		Row %	33.0%	67.0%	100.0%
		Column %	33.7%	76.3%	53.8%
		Total %	17.8%	36.1%	53.8%
	Not sure	Count	44	4	48
		Row %	91.7%	8.3%	100.0%
		Column %	49.4%	5.0%	28.4%
		Total %	26.0%	2.4%	28.4%

	Disagree	Count	7	0	7
		Row %	100.0%	0.0%	100.0%
		Column %	7.9%	0.0%	4.1%
		Total %	4.1%	0.0%	4.1%
	Strongly disagree	Count	5	0	5
		Row %	100.0%	0.0%	100.0%
		Column %	5.6%	0.0%	3.0%
		Total %	3.0%	0.0%	3.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

34. The temperature in this school is comfortable all year round. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

The temperature in this school is comfortable all year round × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
The temperature in this school is comfortable all year round	Strongly agree	ount	2	20	22
			9.1%	90.9%	100.0%
		ow %	2.2%	25.0%	13.0%
		olumn %		1.2%	
		Total %		11.8%	13.0%
	Agree		18	60	78
		ount	23.1%	76.9%	100.0%
		Row %			
		Column %	20.2%	75.0%	46.2%

	Total %	10.7%	35.5%	46.2 %
Not sure	ount	29	0	29
	Row %	100.0%	0.0%	100.0 %
		32.6%	0.0%	17.2 %
	olumn %	17.2%	0.0%	17.2 %
	Total %			
Disagree	ount	33	0	33
	Row %	100.0%	0.0%	100.0 %
		37.1%	0.0%	19.5 %
	olumn %	19.5%	0.0%	19.5 %
	Total %			
Strongly disagree	ount	7	0	7
	ow %	100.0%	0.0%	100.0 %
		7.90		4
	%	.00%	.10%	
	otal %	4.10 %	.00%	4 .10%
Total		89		1
	ount		0	69
	ow %	52.7 0%	7.30%	1 00%
	C	100		1
	olumn %	%	00%	00%
	otal %	52.7 0%	7.30%	1 00%

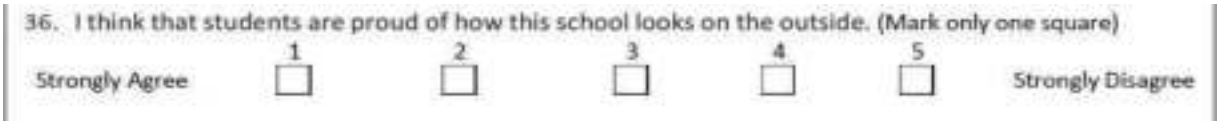
35. The school grounds are kept clean. (Mark only one square)

Strongly Agree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Disagree

The school grounds are kept clean × In which country is your school located

	In which country is your school located	Total

			South Africa	Singapore	
The school grounds are kept clean	Strongly agree	Count	7	20	27
		Row %	25.9%	74.1%	100.0%
		Column %	7.9%	25.0%	16.0%
		Total %	4.1%	11.8%	16.0%
	Agree	Count	39	59	98
		Row %	39.8%	60.2%	100.0%
		Column %	43.8%	73.8%	58.0%
		Total %	23.1%	34.9%	58.0%
	Not sure	Count	34	1	35
		Row %	97.1%	2.9%	100.0%
		Column %	38.2%	1.3%	20.7%
		Total %	20.1%	0.6%	20.7%
	Disagree	Count	4	0	4
		Row %	100.0%	0.0%	100.0%
		Column %	4.5%	0.0%	2.4%
		Total %	2.4%	0.0%	2.4%
	Strongly disagree	Count	5	0	5
		Row %	100.0%	0.0%	100.0%
		Column %	5.6%	0.0%	3.0%
		Total %	3.0%	0.0%	3.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



I think that students are proud of how this school looks on the outside × In which country is your school located

		In which country is your school located	Total

			South Africa	Singapore	
I think that students are proud of how this school looks on the outside	Strongly agree	Count	5	30	35
		Row %	14.3%	85.7%	100.0%
		Column %	5.6%	37.5%	20.7%
		Total %	3.0%	17.8%	20.7%
	Agree	Count	50	50	100
		Row %	50.0%	50.0%	100.0%
		Column %	56.2%	62.5%	59.2%
		Total %	29.6%	29.6%	59.2%
	Not sure	Count	30	0	30
		Row %	100.0%	0.0%	100.0%
		Column %	33.7%	0.0%	17.8%
		Total %	17.8%	0.0%	17.8%
	Disagree	Count	1	0	1
		Row %	100.0%	0.0%	100.0%
		Column %	1.1%	0.0%	0.6%
		Total %	0.6%	0.0%	0.6%
	Strongly disagree	Count	3	0	3
		Row %	100.0%	0.0%	100.0%
		Column %	3.4%	0.0%	1.8%
		Total %	1.8%	0.0%	1.8%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

37. Broken things at this school get fixed quickly. (Mark only one square)

Strongly Agree	1	2	3	4	5	Strongly Disagree
	☐	☐	☐	☐	☐	

Broken things at this school get fixed quickly × In which country is your school located

			In which country is your school located	
			South Africa	Singapore
Broken things at this school get fixed	Strongly Agree	Count	5	21

quickly		Row %	19.2%	80.8%
		Column %	5.6%	26.3%
		Total %	3.0%	12.4%
	Agree	Count	47	59
		Row %	44.3%	55.7%
		Column %	52.8%	73.8%
		Total %	27.8%	34.9%
	Not sure	Count	30	0
		Row %	100.0%	0.0%
		Column %	33.7%	0.0%
		Total %	17.8%	0.0%
	Disagree	Count	3	0
		Row %	100.0%	0.0%
		Column %	3.4%	0.0%
		Total %	1.8%	0.0%
	Strongly disagree	Count	4	0
		Row %	100.0%	0.0%
		Column %	4.5%	0.0%
		Total %	2.4%	0.0%
Total		Count	89	80
		Row %	52.7%	47.3%
		Column %	100.0%	100.0%
		Total %	52.7%	47.3%

38. Are the following programmes or services currently available AT THIS SCHOOL fors learners in any of grades K-12 or comparable ungraded levels, regardless of funding source?

(*Mark only one square for each line.*)	Yes	No
(a) Before-school or after-school programme providing instruction beyond the normal school day for learners who need academic assistance	☐	☐
(b) Before-school or after-school programme providing instruction beyond the normal school day for learners who seek academic advancement or enrichment	☐	☐
(c) Before-school or after-school	☐	☐

Before-school or after-school program providing instruction beyond the normal school day for students who need academic assistance × In which country is your school located

	In which country is your school located		
	South Africa	Singapore	Total

Before-school or after-school program providing instruction beyond the normal school day for students who need academic assistance	No	Count	67	0	67
		Row %	100.0%	.0%	100.0%
		Column %	75.3%	.0%	39.6%
		Total %	39.6%	0.0%	39.6%
	Yes	Count	22	80	102
		Row %	21.6%	78.4%	100.0%
		Column %	24.7%	100.0%	60.4%
		Total %	13.0%	47.3%	60.4%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Before-school or after-school program providing instruction beyond the normal school day for students who seek academic advancement or enrichment × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Before-school or after-school program providing instruction beyond the normal school day for students who seek academic advancement or enrichment	No	Count	82	0	82
		Row %	100.0%	.0%	100.0%
		Column %	92.1%	.0%	48.5%
		Total %	48.5%	0.0%	48.5%
	Yes	Count	7	80	87
		Row %	8.0%	92.0%	100.0%
		Column %	7.9%	100.0%	51.5%
		Total %	4.1%	47.3%	51.5%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Before-school or after-school day care programs × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
Before-school or after-school day care programs	No	Count	87	0	87
		Row %	100.0%	0.0%	100.0%
		Column %	97.8%	0.0%	51.5%
		Total %	51.5%	0.0%	51.5%
	Yes	Count	2	80	82
		Row %	2.4%	97.6%	100.0%
		Column %	2.2%	100.0%	48.5%
		Total %	1.2%	47.3%	48.5%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

39. LAST summer (2021) or LAST school year (2021), were summer school activities or academic intersessions provided for students enrolled in this school who needed ACADEMIC ASSISTANCE? (*Mark only one square*) ☐ Yes ☐ No

LAST summer (2021) or LAST school year (2021), were summer school activities or academic intersessions provided for students enrolled in this school who needed ACADEMIC ASSISTANCE? × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
LAST summer (2021) or LAST school	No	Count	85	0	85
		Row %			
		Column			

year (2021), were summer school activities or academic intersessions provided for students enrolled in this school who needed ACADEMIC ASSISTANCE?		% Total %	100.0% 95.5%	.0% .0%	100.0% 50.3%
			50.3%	0.0%	50.3%
	Yes	Count Row %	4	80	84
		Column %	4.8%	95.2%	100.0%
		Total %	4.5%	100.0%	49.7%
			2.4%	47.3%	49.7%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

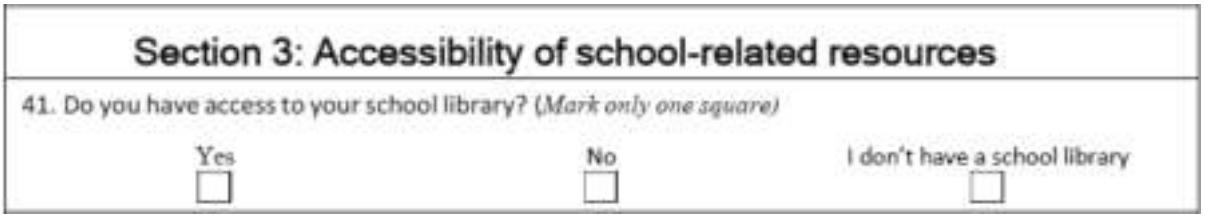
40. LAST summer (2011) or LAST school year (2010-11), were summer school activities or academic intersessions provided for students enrolled in this school who sought ACADEMIC ADVANCEMENT OR ENRICHMENT? (*Mark only one square*)	Yes ☐	No ☐

LAST summer (2021) or LAST school year (2021), were summer school activities or academic intersessions provided for students enrolled in this school who sought ACADEMIC ADVANCEMENT OR ENRICHMENT? × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
LAST summer (2021) or LAST school year (2021), were summer school activities or academic intersessions provided for students enrolled in this school	No	Count	86	0	86
		Row % Column %	100.0%	.0%	100.0%
		Total %	96.6%	.0%	50.9%

who sought ACADEMIC ADVANCEMENT OR ENRICHMENT?					
			50.9%	0.0%	50.9%
	Yes	Count	3	80	83
		Row %	3.6%	96.4%	100.0%
		Column %	3.4%	100.0%	49.1%
		Total %	1.8%	47.3%	49.1%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

School-related resources accessibility and Mathematics Achievement



Section 3: Accessibility of school-related resources

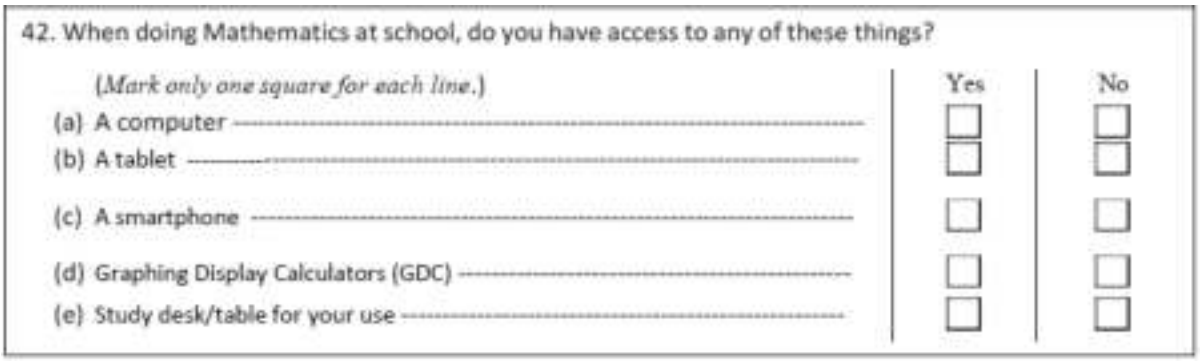
41. Do you have access to your school library? (*Mark only one square*)

Yes ☐ No ☐ I don't have a school library ☐

Do you have access to your school library × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
Do you have access to your school library	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%

		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



When doing Mathematics at school, do you have access to A computer × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
When doing Mathematics at school, do you have access to A computer	No	Count	48	3	51
		Row %	94.1%	5.9%	100.0%
		Column %	53.9%	3.8%	30.2%
		Total %	28.4%	1.8%	30.2%
	Yes	Count	41	77	118
		Row %	34.7%	65.3%	100.0%
		Column %	46.1%	96.3%	69.8%
		Total %	24.3%	45.6%	69.8%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

When doing Mathematics at school, do you have access to A tablet × In which country is your school located

			In which country
			South Africa
When doing Mathematics at school, do you have access to A tablet	No	Count	73
		Row %	90.10%
		Column %	
		Total %	
	Yes	Count	
		Row %	
		Column %	
		Total %	
Total		Count	
		Row %	
		Column %	1
		Total %	

When doing Mathematics at school, do you have access to A smartphone × In which country is your school located

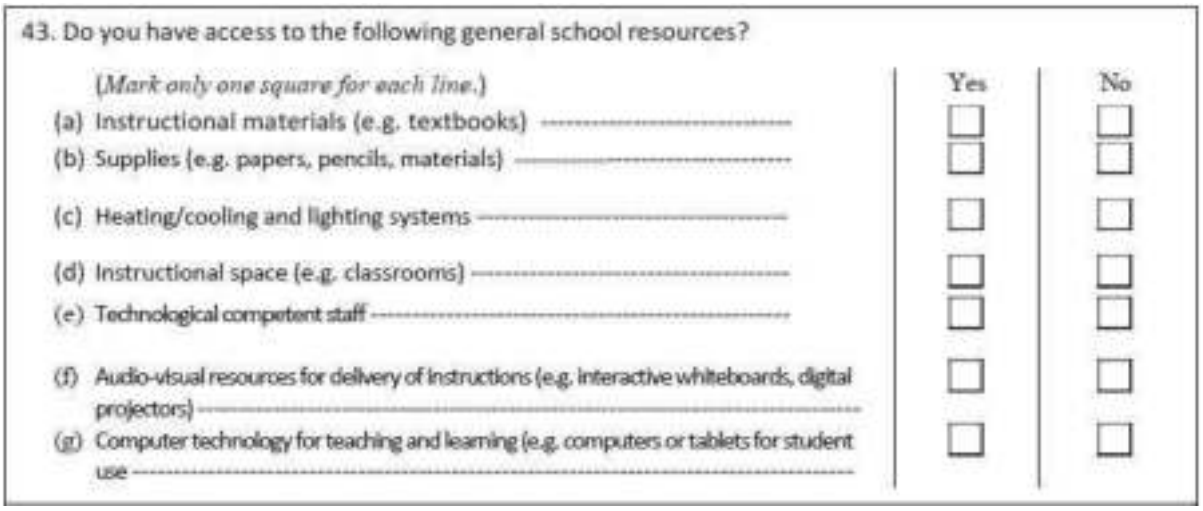
			In which country is your school located		
			South Africa	Singapore	Total
When doing Mathematics at school, do you have access to A smartphone	No	Count	3	0	3
		Row %	100.0%	0.0%	100.0%
		Column %	3.4%	0.0%	1.8%
		Total %	1.8%	0.0%	1.8%
	Yes	Count	86	80	166
		Row %	51.8%	48.2%	100.0%
		Column %	96.6%	100.0%	98.2%
		Total %	50.9%	47.3%	98.2%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

When doing Mathematics at school, do you have access to A Graphing Display Calculator (GDC) × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
When doing Mathematics at school, do you have access to A Graphing Display Calculator (GDC)	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

When doing Mathematics at school, do you have access to Study desk/table for your use × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
When doing Mathematics at school, do you have access to Study desk/table for your use	No	Count	1	0	1
		Row %	100.0%	0.0%	100.0%
		Column %	1.1%	0.0%	0.6%
		Total %	0.6%	0.0%	0.6%
	Yes	Count	88	80	168
		Row %	52.4%	47.6%	100.0%
		Column %	98.9%	100.0%	99.4%
		Total %	52.1%	47.3%	99.4%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



43. Do you have access to the following general school resources?

(*Mark only one square for each line.*)

	Yes	No
(a) Instructional materials (e.g. textbooks)	☐	☐
(b) Supplies (e.g. papers, pencils, materials)	☐	☐
(c) Heating/cooling and lighting systems	☐	☐
(d) Instructional space (e.g. classrooms)	☐	☐
(e) Technological competent staff	☐	☐
(f) Audio-visual resources for delivery of instructions (e.g. interactive whiteboards, digital projectors)	☐	☐
(g) Computer technology for teaching and learning (e.g. computers or tablets for student use	☐	☐

Do you have access to Instructional materials (e.g., textbooks) × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you have access to Instructional materials (e.g., textbooks)	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you have access to Supplies (e.g., papers, pencils, materials) × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you have access to Supplies (e.g., papers, pencils, materials)	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you have access to Heating or cooling and lighting systems × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you have access to Heating or cooling and lighting systems	No	Count	1	0	1
		Row %	100.0%	0.0%	100.0%
		Column %	1.1%	0.0%	0.6%
		Total %	0.6%	0.0%	0.6%
	Yes	Count	88	80	168
		Row %	52.4%	47.6%	100.0%
		Column %	98.9%	100.0%	99.4%
		Total %	52.1%	47.3%	99.4%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you have access to Instructional space (e.g., classrooms) × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you have access to Instructional space (e.g., classrooms)	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%

	Total %	52.7%	47.3%	100.0%

Do you have access to Technologically competent staff × In which country is your school located

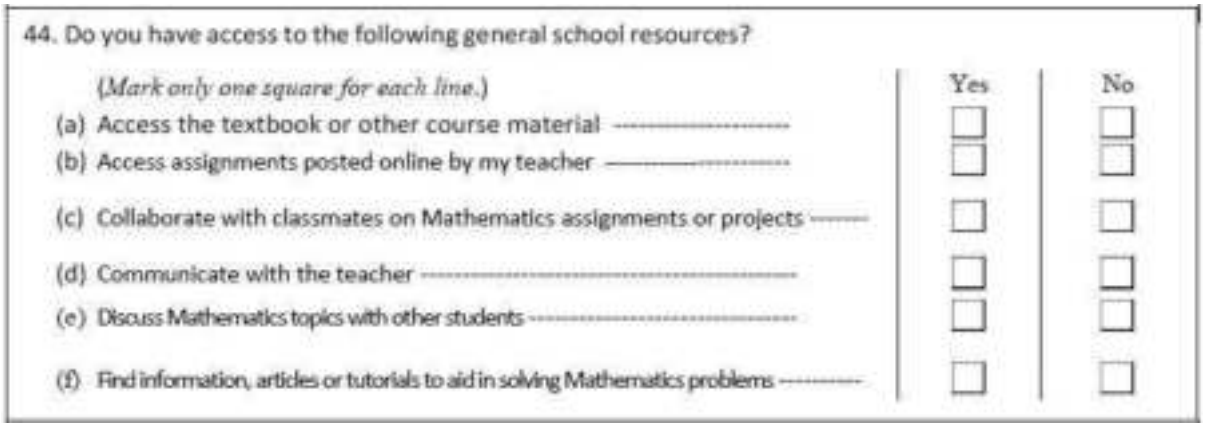
			In which country is your school located		
			South Africa	Singapore	Total
Do you have access to Technologically competent sta???	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you have access to Audio-visual resources for delivery of instruction (e.g., interactive white boards, digital projectors) × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you have access to Audio-visual resources for delivery of instruction (e.g., interactive white boards, digital projectors)	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you have access to Computer technology for teaching and learning (e.g., computers or tablets for student use) × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you have access to Computer technology for teaching and learning (e.g., computers or tablets for student use)	No	Count	7	2	9
		Row %	77.8%	22.2%	100.0%
		Column %	7.9%	2.5%	5.3%
		Total %	4.1%	1.2%	5.3%
	Yes	Count	16	75	91
		Row %	17.6%	82.4%	100.0%
		Column %	18.0%	93.8%	53.8%
		Total %	9.5%	44.4%	53.8%
	3	Count	66	3	69
		Row %	95.7%	4.3%	100.0%
		Column %	74.2%	3.8%	40.8%
		Total %	39.1%	1.8%	40.8%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



44. Do you have access to the following general school resources?

(*Mark only one square for each line.*)

	Yes	No
(a) Access the textbook or other course material	☐	☐
(b) Access assignments posted online by my teacher	☐	☐
(c) Collaborate with classmates on Mathematics assignments or projects	☐	☐
(d) Communicate with the teacher	☐	☐
(e) Discuss Mathematics topics with other students	☐	☐
(f) Find information, articles or tutorials to aid in solving Mathematics problems	☐	☐

Do you access the Internet to Access the textbook or other course material × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you access the Internet to Access the textbook or other course material	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%

Column %	100.0%	100.0%	100.0%

		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you access the Internet to Access assignments posted online by my teacher × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you access the Internet to Access assignments posted online by my teacher	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you access the Internet to Collaborate with classmates on Mathematics assignments or projects × In which country is your school located

				sc
Do you access the Internet to Collaborate with classmates on Mathematics assignments or projects	Yes	Count		
		Row %		
		Column %		
		Total %		
Total		Count		
		Row %		

			Column %		
			Total %		

Do you access the Internet to Communicate with the teacher × In which country is your school located

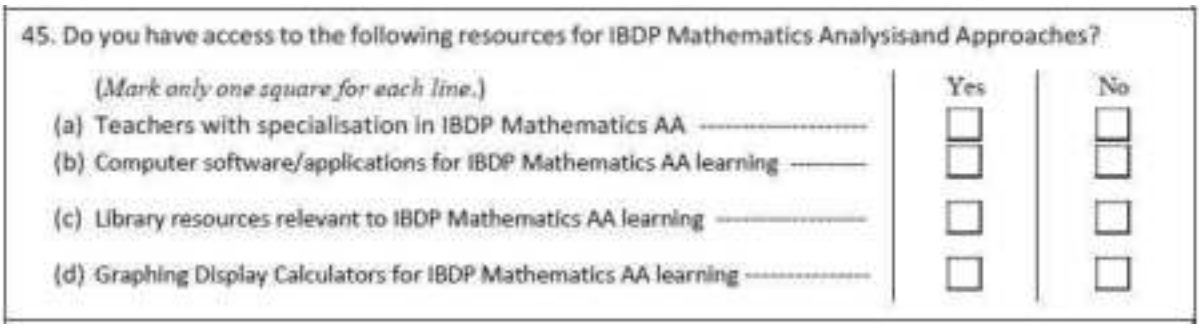
			In which country is your school located		
			South Africa	Singapore	Total
Do you access the Internet to Communicate with the teacher	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you access the Internet to Discuss mathematics topics with other students × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you access the Internet to Discuss mathematics topics with other students	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you access the Internet to Find information, articles, or tutorials to aid in understanding Mathematics concepts × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you access the Internet to Find information, articles, or tutorials to aid in solving mathematics problems	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



45. Do you have access to the following resources for IBDP Mathematics Analysisand Approaches?

(*Mark only one square for each line.*)

	Yes	No
(a) Teachers with specialisation in IBDP Mathematics AA	☐	☐
(b) Computer software/applications for IBDP Mathematics AA learning	☐	☐
(c) Library resources relevant to IBDP Mathematics AA learning	☐	☐
(d) Graphing Display Calculators for IBDP Mathematics AA learning	☐	☐

Teachers with a specialization in IBDP Mathematics AA × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Teachers with a specialization in IBDP Mathematics AA	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Computer software or applications for IBDP Mathematics AA learning × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Computer software or applications for IBDP Mathematics AA learning	No	Count	8	3	11
		Row %	72.7%	27.3%	100.0%
		Column %	9.0%	3.8%	6.5%
		Total %	4.7%	1.8%	6.5%
	Yes	Count	13	74	87
		Row %	14.9%	85.1%	100.0%
		Column %	14.6%	92.5%	51.5%
		Total %	7.7%	43.8%	51.5%
	3	Count	68	3	71
		Row %	95.8%	4.2%	100.0%
		Column %	76.4%	3.8%	42.0%
		Total %	40.2%	1.8%	42.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Library resources relevant to IBDP Mathematics AA learning × In which country is your school locate

			In which country is your school located		
			South Africa	Singapore	Total
Library resources relevant to IBDP Mathematics AA learning	No	Count	4	0	4
		Row %	100.0%	0.0%	100.0%
		Column %	4.5%	0.0%	2.4%
		Total %	2.4%	0.0%	2.4%
	Yes	Count	14	80	94
		Row %	14.9%	85.1%	100.0%
		Column %	15.7%	100.0%	55.6%
		Total %	8.3%	47.3%	55.6%
	3	Count	71	0	71

Row	%	100.0%	0.0%	100.0%

	Column %	79.8%	0.0%	42.0%
	Total %	42.0%	0.0%	42.0%
Total	Count	89	80	169
	Row %	52.7%	47.3%	100.0%
	Column %	100.0%	100.0%	100.0%
	Total %	52.7%	47.3%	100.0%

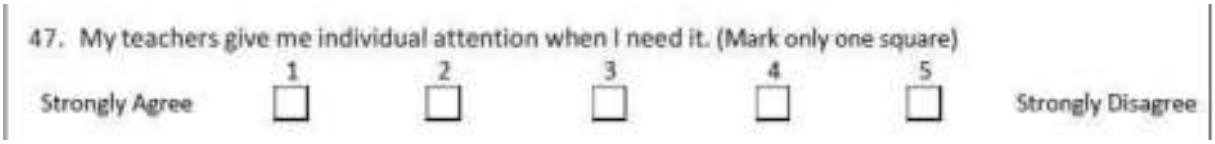
Graphing Display Calculators for IBDP Mathematics AA learning × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Graphing Display Calculators for IBDP Mathematics AA learning	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

My teachers praise me when I work hard in school × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
My teachers praise me when I work hard in school	Strongly agree	Count	16	42	58
		Row %			
		Column	27.6%	72.4%	100.0%

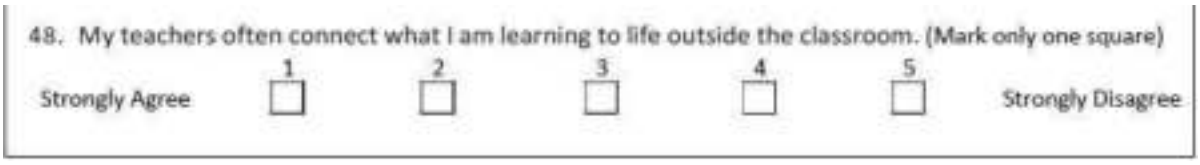
		%	18.0%	52.5%	34.3%
		Total %	9.5%	24.9%	34.3%
	Agree	Count	49	37	86
		Row %	57.0%	43.0%	100.0%
		Column %	55.1%	46.3%	50.9%
		Total %	29.0%	21.9%	50.9%
	Not sure	Count	16	1	17
		Row %	94.1%	5.9%	100.0%
		Column %	18.0%	1.3%	10.1%
		Total %	9.5%	0.6%	10.1%
	Disagree	Count	4	0	4
		Row %	100.0%	0.0%	100.0%
		Column %	4.5%	0.0%	2.4%
		Total %	2.4%	0.0%	2.4%
	Strongly disagree	Count	4	0	4
		Row %	100.0%	0.0%	100.0%
		Column %	4.5%	0.0%	2.4%
		Total %	2.4%	0.0%	2.4%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



My teachers give me individual attention when I need it × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
My teachers give me individual attention when I need it	Strongly agree	Count	18	68	86
		Row %	20.9%	79.1%	100.0%
		Column %	20.2%	85.0%	50.9%
		Total %			

				10.7%	40.2%	50.9%
	Agree		Count	44	12	56
		Row %	Column %	78.6%	21.4%	100.0%
				49.4%	15.0%	33.1%
			Total %	26.0%	7.1%	33.1%
	Not sure		Count	19	0	19
		Row %	Column %	100.0%	0.0%	100.0%
				21.3%	0.0%	11.2%
			Total %	11.2%	0.0%	11.2%
	Disagree		Count	3	0	3
		Row %	Column %	100.0%	0.0%	100.0%
				3.4%	0.0%	1.8%
			Total %	1.8%	0.0%	1.8%
	Strongly disagree		Count	5	0	5
		Row %	Column %	100.0%	0.0%	100.0%
				5.6%	0.0%	3.0%
			Total %	3.0%	0.0%	3.0%
Total			Count	89	80	169
			Row %	52.7%	47.3%	100.0%
			Column %	100.0%	100.0%	100.0%
			Total %	52.7%	47.3%	100.0%



My teachers often connect what I am learning to life outside the classroom × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
My teachers often connect what I am learning to	Strongly agree	Count	16	47	63

life outside the classroom		Row %	25.4%	74.6%	100.0%
		Column %	18.0%	58.8%	37.3%
		Total %	9.5%	27.8%	37.3%
	Agree	Count	40	32	72
		Row %	55.6%	44.4%	100.0%
		Column %	44.9%	40.0%	42.6%
		Total %	23.7%	18.9%	42.6%
	Not sure	Count	25	1	26
		Row %	96.2%	3.8%	100.0%
		Column %	28.1%	1.3%	15.4%
		Total %	14.8%	0.6%	15.4%
	Disagree	Count	4	0	4
		Row %	100.0%	0.0%	100.0%
		Column %	4.5%	0.0%	2.4%
		Total %	2.4%	0.0%	2.4%
	Strongly disagree	Count	4	0	4
		Row %	100.0%	0.0%	100.0%
		Column %	4.5%	0.0%	2.4%
		Total %	2.4%	0.0%	2.4%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

49. The things I'm learning in school are important to me. (Mark only one square)

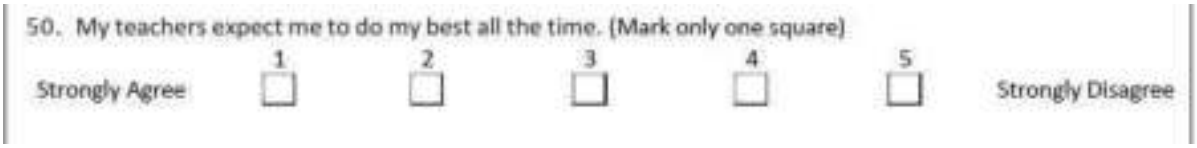
	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

The things I'm learning in school are important to me × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
The things I'm learning in school are	Strongly agree	Count	16	66	82

important to me		Row %	19.5%	80.5%	100.0%

		Column %	18.0%	82.5%	48.5%
		Total %	9.5%	39.1%	48.5%
	Agree	Count	44	14	58
		Row %	75.90%	24.1%	100.0%
		Column %	49.40%	17.5%	34.3%
		Total %	26.0%	8.3%	34.3%
	Not sure	Count	22	0	22
		Row %	100.0%	0.0%	100.0%
		Column %	24.7%	0.0%	13.0%
		Total %	13.0%	0.0%	13.0%
		Row %	100.0%	0.0%	100.0%
		Column %	3.4%	0.0%	1.8%
		Total %	1.8%	0.0%	1.8%
	Strongly disagree	Count	4	0	4
		Row %	100.0%	0.0%	100.0%
		Column %	4.5%	0.0%	2.4%
		Total %	2.4%	0.0%	2.4%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



My teachers expect me to do my best all the time × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
My teachers expect me to do my best all the time	Strongly agree	Count	20	49	69
		Row %	29.0%	71.0%	100.0%
		Column %	22.5%	61.3%	40.8%
		Total %	11.8%	29.0%	40.8%
	Agree	Count	45	30	75
		Row %	60.0%	40.0%	100.0%
		Column %	50.6%	37.5%	44.4%
		Total %	26.6%	17.8%	44.4%
	Not sure		18	1	19

		Count	94.7%	5.3%	100.0%
		Row %	20.2%	1.3%	11.2%
		Column %	10.7%	0.6%	11.2%
		Total %			
	Disagree	Count	2	0	2
		Row %	100.0%	0.0%	100.0%
		Column %	2.2%	0.0%	1.2%
		Total %	1.2%	0.0%	1.2%
	Strongly disagree	Count	4	0	4
		Row %	100.0%	0.0%	100.0%
		Column %	4.5%	0.0%	2.4%
		Total %	2.4%	0.0%	2.4%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

51. My teachers really care about me. (Mark only one square)

Strongly Agree 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Strongly Disagree

My teachers really care about me × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
My teachers really care about me	Strongly agree	Count	13	63	76
		Row %	17.1%	82.9%	100.0%
		Column %	14.6%	78.8%	45.0%
		Total %	7.7%	37.3%	45.0%
	Agree	Count	48	17	65
		Row %	73.8%	26.2%	100.0%
		Column %	53.9%	21.3%	38.5%
		Total %	28.4%	10.1%	38.5%
	Not sure	Count	22	0	22
		Row %	100.0%	0.0%	100.0%
		Column %	24.7%	0.0%	13.0%
		Total %	13.0%	0.0%	13.0%
	Disagree	Count	2	0	2
		Row %	100.0%	0.0%	100.0%

		Column %	2.2%	0.0%	1.2%
		Total %	1.2%	0.0%	1.2%
	Strongly disagree	Count	4	0	4
		Row %	100.0%	0.0%	100.0%
		Column %	4.5%	0.0%	2.4%
		Total %	2.4%	0.0%	2.4%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%

52. I can talk to my teachers about problems I am having in class. (Mark only one square)

	1	2	3	4	5	
Strongly Agree	☐	☐	☐	☐	☐	Strongly Disagree

I can talk to my teachers about problems I am having in class × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
I can talk to my teachers about problems I am having in class	Strongly agree	Count	16	53	69
		Row %	23.2%	76.8%	100.0%
		Column %	18.0%	66.3%	40.8%
		Total %	9.5%	31.4%	40.8%
	Agree	Count	46	26	72
		Row %	63.9%	36.1%	100.0%
		Column %	51.7%	32.5%	42.6%
		Total %	27.2%	15.4%	42.6%
	Not sure	Count	21	1	22
		Row %	95.5%	4.5%	100.0%
		Column %	23.6%	1.3%	13.0%
		Total %	12.4%	0.6%	13.0%
	Disagree	Count	2	0	2
		Row %	100.0%	0.0%	100.0%
		Column %	2.2%	0.0%	1.2%
		Total %	1.2%	0.0%	1.2%
			4	0	4

	Strongly disagree	Count	100.0%	0.0%	100.0%
		Row %	4.5%	0.0%	2.4%
		Column %	2.4%	0.0%	2.4%
		Total %			
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

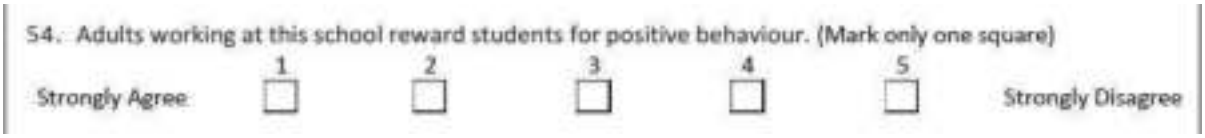
53. I can talk to a teacher or other adult at this school about something that is bothering me. (Mark only one square)

Strongly Agree 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Strongly Disagree

I can talk to a teacher or other adult at this school about something that is bothering me × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
I can talk to a teacher or other adult at this school about something that is bothering me	Strongly agree	Count	12	61	73
		Row %	16.4%	83.6%	100.0%
		Column %	13.5%	76.3%	43.2%
		Total %	7.1%	36.1%	43.2%
	Agree	Count	46	19	65
		Row %	70.8%	29.2%	100.0%
		Column %	51.7%	23.8%	38.5%
		Total %	27.2%	11.2%	38.5%
	Not sure	Count	24	0	24
		Row %	100.0%	0.0%	100.0%
		Column %	27.0%	0.0%	14.2%
		Total %	14.2%	0.0%	14.2%
	Disagree	Count	3	0	3
		Row %	100.0%	0.0%	100.0%
		Column %	3.4%	0.0%	1.8%
		Total %	1.8%	0.0%	1.8%
	Strongly disagree	Count	4	0	4
		Row %	100.0%	0.0%	100.0%
		Column %	4.5%	0.0%	2.4%
		Total %	2.4%	0.0%	2.4%
Total		Count	169		
		Row %	100.0%		

		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



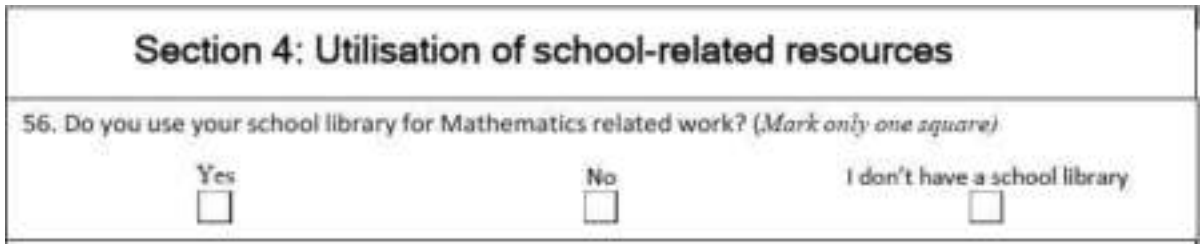
Adults working at this school reward students for positive behavior × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Adults working at this school reward students for positive behaviour	Strongly agree	Count	15	53	68
		Row %	22.10%	77.90%	100.00%
		Column %	16.90%	66.30%	40.20%
		Total %	8.90%	31.40%	40.20%
	Agree	Count	45	26	71
		Row %	63.4%	36.6%	100.0%
		Column %	50.6%	32.5%	42.0%
		Total %	26.6%	15.4%	42.0%
	Not sure	Count	23	1	24
		Row %	95.8%	4.2%	100.0%
		Column %	25.8%	1.3%	14.2%
		Total %	13.6%	0.6%	14.2%
	Disagree	Count	2	0	2
		Row %	100.0%	0.0%	100.0%
		Column %	2.2%	0.0%	1.2%
		Total %	1.2%	0.0%	1.2%
	Strongly disagree	Count	4	0	4
		Row %	100.0%	0.0%	100.0%
		Column %	4.5%	0.0%	2.4%
		Total %	2.4%	0.0%	2.4%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Discipline is fair × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
Discipline is fair	Strongly agree	Count	11	62	73
		Row %	15.1%	84.9%	100.0%
		Column %	12.4%	77.5%	43.2%
		Total %	6.5%	36.7%	43.2%
	Agree	Count	55	18	73
		Row %	75.3%	24.7%	100.0%
		Column %	61.8%	22.5%	43.2%
		Total %	32.5%	10.7%	43.2%
	Not sure	Count	23	0	23
		Row %	100.0%	0.0%	100.0%
		Column %	25.8%	0.0%	13.6%
		Total %	13.6%	0.0%	13.6%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

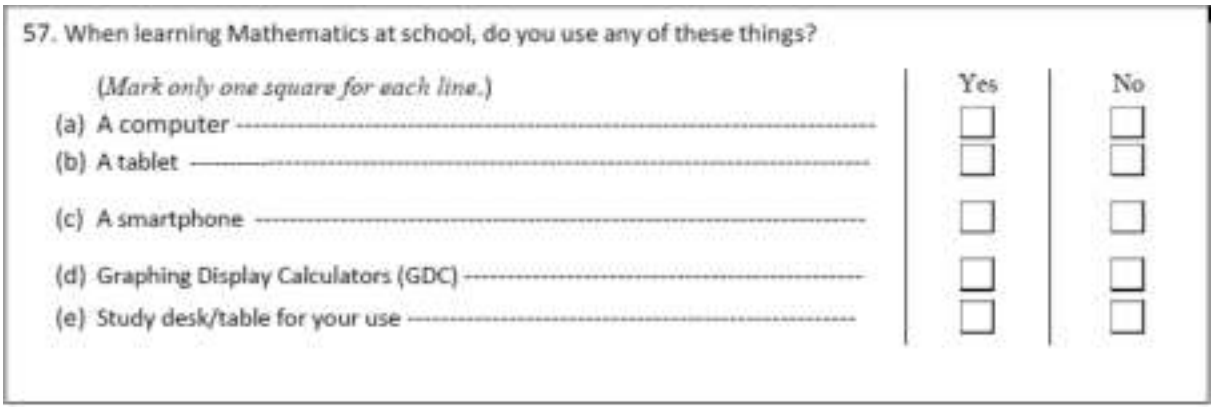
School-related resources utilisation and Mathematics Achievement



Do you use your school library for Mathematics related work? × In which country is your school located

	In which country is your school located		
	South Africa	Singapore	Total

Do you use your school library for Mathematics related work?	No	Count	3	0	3
		Row %	100.0%	0.0%	100.0%
		Column %	3.4%	0.0%	1.8%
		Total %	1.8%	0.0%	1.8%
	Yes	Count	86	80	166
		Row %	51.8%	48.2%	100.0%
		Column %	96.6%	100.0%	98.2%
		Total %	50.9%	47.3%	98.2%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



57. When learning Mathematics at school, do you use any of these things?

(*Mark only one square for each line.*)

	Yes	No
(a) A computer	☐	☐
(b) A tablet	☐	☐
(c) A smartphone	☐	☐
(d) Graphing Display Calculators (GDC)	☐	☐
(e) Study desk/table for your use	☐	☐

When learning Mathematics at school, I use A computer × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
When learning Mathematics at school, I use A computer	No	Count	57	4	61
		Row %	93.4%	6.6%	100.0%
		Column %	64.0%	5.0%	36.1%
		Total %	33.7%	2.4%	36.1%
	Yes	Count	32	76	108
		Row %	29.6%	70.4%	100.0%
		Column %	36.0%	95.0%	63.9%
		Total %	18.9%	45.0%	63.9%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

When learning Mathematics at schoolA tablet × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
When learning Mathematics at schoolA tablet	No	Count	79	8	87
		Row %	90.8%	9.2%	100.0%
		Column %	88.8%	10.0%	51.5%
		Total %	46.7%	4.7%	51.5%
	Yes	Count	10	72	82
		Row %	12.2%	87.8%	100.0%
		Column %	11.2%	90.0%	48.5%
		Total %	5.9%	42.6%	48.5%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

When learning Mathematics at schoolA smartphone × In which country is your school located

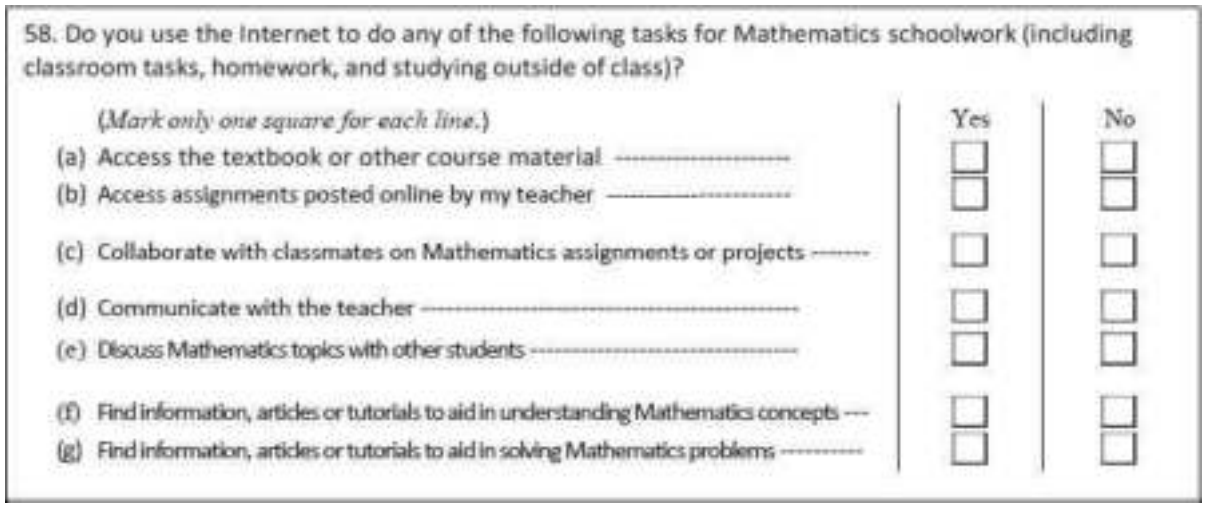
			In which country is your school located		Total
			South Africa	Singapore	
When learning Mathematics at schoolA smartphone	No	Count	19	0	19
		Row %	100.0%	0.0%	100.0%
		Column %	21.3%	0.0%	11.2%
		Total %	11.2%	0.0%	11.2%
	Yes	Count	70	80	150
		Row %	46.7%	53.3%	100.0%
		Column %	78.7%	100.0%	88.8%
		Total %	41.4%	47.3%	88.8%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

When learning Mathematics at schoolA Graphing Display Calculator (GDC) × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
When learning Mathematics at schoolA Graphing Display Calculator (GDC)	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

When learning Mathematics at schoolDesk or table for your use × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
When learning Mathematics at schoolDesk or table for your use	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



58. Do you use the Internet to do any of the following tasks for Mathematics schoolwork (including classroom tasks, homework, and studying outside of class)?

(*Mark only one square for each line.*)	Yes	No
(a) Access the textbook or other course material	☐	☐
(b) Access assignments posted online by my teacher	☐	☐
(c) Collaborate with classmates on Mathematics assignments or projects	☐	☐
(d) Communicate with the teacher	☐	☐
(e) Discuss Mathematics topics with other students	☐	☐
(f) Find information, articles or tutorials to aid in understanding Mathematics concepts	☐	☐
(g) Find information, articles or tutorials to aid in solving Mathematics problems	☐	☐

Do you use the Internet to Access the textbook or other course material × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you use the Internet to Access the textbook or other course material	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you use the Internet to Access assignments posted online by my teacher × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you use the Internet to Access assignments posted online by my teacher	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%

		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you use the Internet to Collaborate with classmates on Mathematics assignments or projects × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	To
Do you use the Internet to Collaborate with classmates on Mathematics assignments or projects	Yes	Count	89	80	
		Row %	52.7%	47.3%	
		Column %	100.0%	100.0%	
		Total %	52.7%	47.3%	
Total		Count	89	80	
		Row %	52.7%	47.3%	
		Column %	100.0%	100.0%	
		Total %	52.70%	47.30%	

Do you use the Internet to Communicate with the teacher × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you use the Internet to Communicate with the teacher	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you use the Internet to Discuss mathematics topics with other students × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you use the Internet to Discuss mathematics topics with other students	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you use the Internet to Find information, articles, or tutorials to aid in understanding Mathematics concepts × In which country is your school located

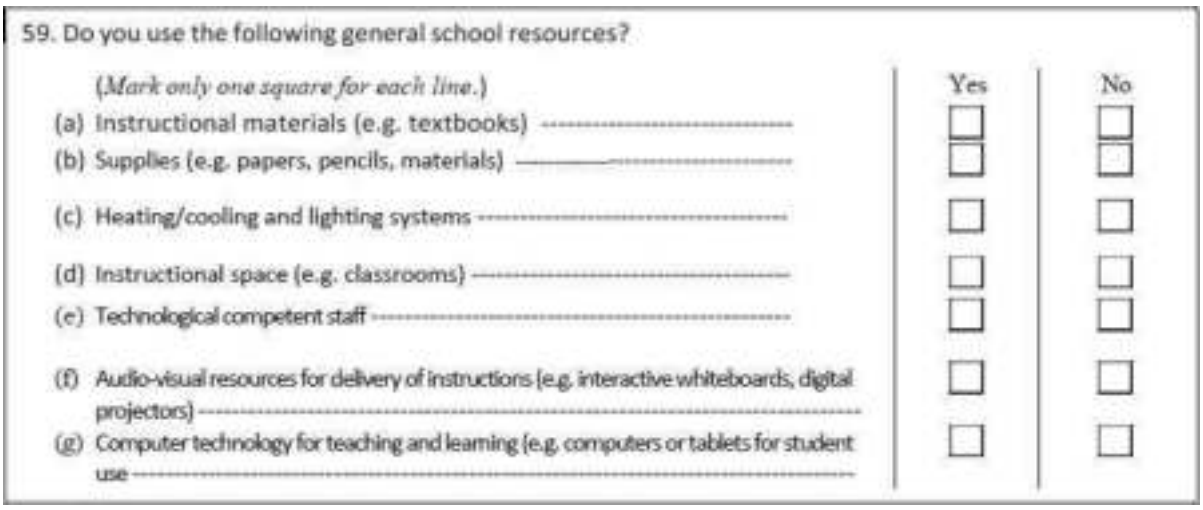
			In which country is your school located		
			South Africa	Singapore	Total
Do you use the Internet to Find information, articles, or tutorials to aid in understanding Mathematics concepts	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you use the Internet to Find information, articles, or tutorials to aid in solving mathematics problems × In which country is your school located

			In which country is your school located

	South Africa	Singapore	Total

Do you use the Internet to Find information, articles, or tutorials to aid in solving mathematics problems	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%


59. Do you use the following general school resources?

(*Mark only one square for each line.*)

	Yes	No
(a) Instructional materials (e.g. textbooks)	☐	☐
(b) Supplies (e.g. papers, pencils, materials)	☐	☐
(c) Heating/cooling and lighting systems	☐	☐
(d) Instructional space (e.g. classrooms)	☐	☐
(e) Technological competent staff	☐	☐
(f) Audio-visual resources for delivery of instructions (e.g. interactive whiteboards, digital projectors)	☐	☐
(g) Computer technology for teaching and learning (e.g. computers or tablets for student use	☐	☐

Do you use Instructional materials (e.g., textbooks) × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
Do you use Instructional materials (e.g., textbooks)	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you use Supplies (e.g., papers, pencils, materials) × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
Do you use Supplies (e.g., papers, pencils, materials)	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you use Heating or cooling and lighting systems × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
Do you use Heating or cooling and lighting systems	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you use Instructional space (e.g., classrooms) × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
Do you use Instructional space (e.g., classrooms)	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%

	Column %	100.0%	100.0%	100.0%
	Total %	52.7%	47.3%	100.0%

Do you use Technologically competent sta??? × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
Do you use Technologically competent sta???	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you use Audio-visual resources for delivery of instruction (e.g., interactive white boards, digital projectors) × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you use Audio-visual resources for delivery of instruction (e.g., interactive white boards, digital projectors)	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%

		Total %	52.7%	47.3%	100.0%

Do you use Computer technology for teaching and learning (e.g., computers or tablets for student use) × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you use Computer technology for teaching and learning (e.g., computers or tablets for student use)	No	Count	7	2	9
		Row %	77.80%	22.20%	100.00%
		Column %	7.90%	2.50%	5.30%
		Total %	4.10%	1.20%	5.30%
	Yes	Count	18	75	93
		Row %	19.40%	80.60%	100.00%
		Column %	20.2%	93.8%	55.0%
		Total %	10.7%	44.4%	55.0%
	2	Count	64	3	67
		Row %	95.5%	4.5%	100.0%
		Column %	71.9%	3.8%	39.6%
		Total %	37.9%	1.8%	39.6%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

60. Do you use the following resources for IBDP Mathematics Analysis andApproaches?

(*Mark only one square for each line.*)

	Yes	No
(a) Teachers with specialisation in IBDP Mathematics AA	☐	☐
(b) Computer software/applications for IBDP Mathematics AA learning	☐	☐
(c) Library resources relevant to IBDP Mathematics AA learning	☐	☐
(d) Graphing Display Calculators for IBDP Mathematics AA learning	☐	☐

Do you use Teachers with a specialization in IBDP Mathematics AA × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you use Teachers with a specialization in IBDP Mathematics AA	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you use Computer software/applications for IBDP Mathematics AA learning × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you use Computer software/applications for IBDP Mathematics AA learning	No	Count	5	2	7
		Row %	71.40%	28.60%	100.00%
		Column %	5.60%	2.50%	4.10%
		Total %	3.0%	1.2%	4.1%
	Yes	Count	16	75	91
		Row %	17.6%	82.4%	100.0%
		Column %	18.0%	93.8%	53.8%
		Total %	9.5%	44.4%	53.8%
	I do not have this resource in my school	Count	68	3	71
		Row %	95.8%	4.2%	100.0%
		Column %	76.4%	3.8%	42.0%
		Total %	40.2%	1.8%	42.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

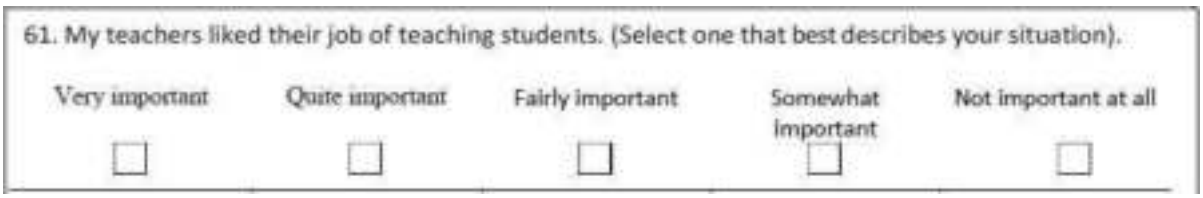
Do you use Library resources relevant to IBDP Mathematics AA learning × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you use Library resources relevant to IBDP Mathematics AA learning	No	Count	5	0	5
		Row %			
		Column %	100.0%	0.0%	100.0%
		Total %	5.6%	0.0%	3.0%
			3.0%	0.0%	3.0%
	Yes	Count	13	80	93
		Row %			
		Column %	14.0%	86.0%	100.0%
			14.6%	100.0%	55.0%
		Total %	7.7%	47.3%	55.0%

	I do not have this resource in my School	Count	71	0	71
		Row %	100.0%	0.0%	100.0%
		Column %	79.8%	0.0%	42.0%
		Total %	42.0%	0.0%	42.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

Do you use Graphing Display Calculators for IBDP Mathematics AA learning × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Do you use Graphing Display Calculators for IBDP Mathematics AA learning	Yes	Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



My teachers liked their job of teaching students × In which country is your school located

		In which country is your school located		
		South Africa	Singapore	Total

My teachers liked their job of teaching students		Count	31	71	102
		Row %	30.4%	69.6%	100.0%
		Column %	34.8%	88.8%	60.4%
		Total %	18.3%	42.0%	60.4%
		Count	36	9	45
		Row %	80.0%	20.0%	100.0%
		Column %	40.4%	11.3%	26.6%
		Total %	21.3%	5.3%	26.6%
		Count	19	0	19
		Row %	100.0%	0.0%	100.0%
		Column %	21.3%	0.0%	11.2%
		Total %	11.2%	0.0%	11.2%
	nt	Count	0	3	
	at all	Row %	0.0%	100.0%	
		Column %	0.0%	1.8%	
		Total %	1.8%	0.0%	1.8%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

62. My teachers spend a lot of time helping students with their personal problems. (Select one that best describes your situation).

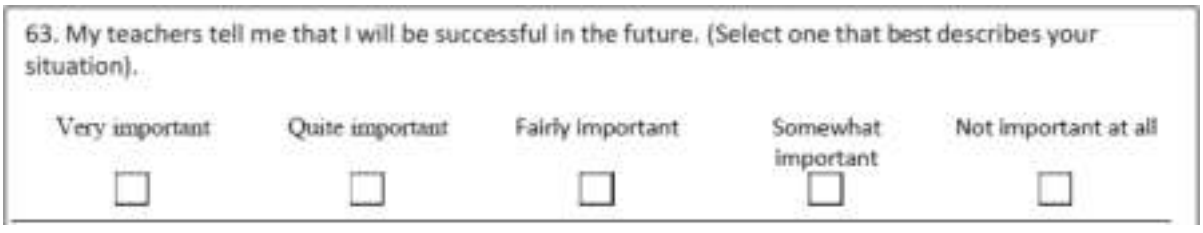
Very important	Quite important	Fairly important	Somewhat important	Not important at all
☐	☐	☐	☐	☐

My teachers spend a lot of time helping students with their personal problems × In which country is your school located

			In which country i your school located	
			South Africa	Singapor e
My teachers spend a lot of time helping students with their personal problems	Very important	Count	15	4
		Row %	8	
		Column %	23.8%	76.2 %
		Total %	16.9%	60.0 %
			8.9%	28.4 %
	Quite	Count	47	3

2					
	important	Row %	59.5%		40.5
		Column %	%	52.8%	40.0
				% 27.8%	18.9
		Total %			%
	Fairly important	Count	23		0
		Row %	100.0%		0.0
			%		

		Column %	25.8%		0.0
		Total %			%
			13.6%		0.0
					%
	Somewhat	Count	1		
			0		
	important	Row %		100.0%	
		Column %			0.0
		Total %		%	
			1.1%		
			0.0%		
				0.6%	
					0.0
				%	
	Not	Count	3		
			0		
	importantat all	Row %		100.0%	
		Column %			0.0
		Total %		%	
			3.4%		
			0.0%		
				1.8%	
					0.0
				%	
Total		Count	89		80
		Row %	52.7%		47.3%
		Column	100.0%		100.0
				%	
		%			
		Total	52.7%		
					47.3
				%	
		%			



My teachers tell me that I will be successful in the future × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
My teachers tell me that I will be successful in the future	Very important	Count	11	44	55
		Row %			
		Column %	20.0%	80.0%	100.0%

	Total %		12.5%	55.0%	32.7%
			6.5%	26.2%	32.7%
Qute important		Count	54	36	90
	Row	%	60.0%	40.0%	100.0%
	Column %		61.4%	45.0%	53.6%
	Total %		32.1%	21.4%	53.6%
Fairly important		Count	19	0	19
		Row %	100.0%	0.0%	100.0%
	Column %		21.6%	0.0%	11.3%
		Total %	11.3%	0.0%	11.3%

	Somewhat important	Count	1	0	1
		Row %	100.0%	0.0%	100.0%
		Column %	1.1%	0.0%	0.6%
		Total %	0.6%	0.0%	0.6%
	Not important at all	Count	3	0	3
		Row %	100.0%	0.0%	100.0%
		Column %	3.4%	0.0%	1.8%
		Total %	1.8%	0.0%	1.8%
Total		Count	88	80	168
		Row %	52.4%	47.6%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.4%	47.6%	100.0%

My teachers call my home to talk to my parents about how I'm doing at school × In which country is your school located

				In which c located
My teachers call my home to talk to my parents about how I'm doing at school	Very important	Count	Row %	South Africa
		Column %		100.0
		Total %		1.1
				0.6
	Quite important	Count	Row %	
		Column %		100.0
		Total %		2.2
				1.2
	Fairly important	Count	Row %	
		Column %		33.3
		Total %		7.9
				4.1
	Somewhat important	Count	Row %	
		Column %		38.6
				19.1
		Total		10.1%

%			
Not important at all	Count		62
	Row %		61.4%
	Column %		69.7%
	Total %		36.7%
Total	Count		89
	Row %		52.7%

		Column %	100.0%
		Total %	52.7%

65. My teachers notice when I am doing a good job and let me know about it. (Select one that best describes your situation).

Very important	Quite important	Fairly important	Somewhat important	Not important at all
☐	☐	☐	☐	☐

My teachers notice when I am doing a good job and let me know about it × In which country is your school located

				In which country is located	
				South Africa	Sin
My teachers notice when I am doing a good job and let me know about it	Very important	Count		14	
		Row %		20.3%	
		Column %		15.7%	
		Total %		8.3%	
	Quite important	Count		53	
		Row %		67.9%	
		Column %		59.6%	
		Total %		31.4%	

	Fairly important	Count	17
		Row %	100.0%
		Column %	19.1%
		Total %	10.1%
	Somewhat important	Count	1
		Row %	100.0%
		Column %	1.1%
		Total %	0.6%
	Not important at all	Count	4
		Row %	100.0%
		Column %	4.5%
		Total %	2.4%
Total		Count	89
		Row %	52.70
		Column %	100.0
		Total %	52.70

66. Our teachers work together to plan classroom activities. (Select one that best describes your situation).

Very important	Quite important	Fairly important	Somewhat important	Not important at all
☐	☐	☐	☐	☐

Our teachers work together to plan classroom activities × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
Our teachers work together to plan classroom activities	Very important	Count	12	55	67
		Row %	17.9%	82.1%	100.0%
		Column %	13.5%	68.8%	39.6%
		Total %	7.1%	32.5%	39.6%
	Quite important	Count	49	25	74
		Row %	66.2%	33.8%	100.0%
		Column %	55.1%	31.3%	43.8%
		Total %	29.0%	14.8%	43.8%
	Fairly important	Count	22	0	22
		Row %	100.0%	0.0%	100.0%
		Column %	24.7%	0.0%	13.0%
		Total %	13.0%	0.0%	13.0%
			1	0	1

		Count	100.0%	0.0%	100.0%
Somewhat important	Row %		1.1%	0.0%	0.6%
	Column %		0.6%	0.0%	0.6%
	Total %				
Not important at all	Count		5	0	5
	Row %		100.0%	0.0%	100.0%
	Column %		5.6%	0.0%	3.0%
	Total %		3.0%	0.0%	3.0%
Total	Count				
	Row %				
	Column %				
	Total		52.7%	47.3%	100.0%
	%				

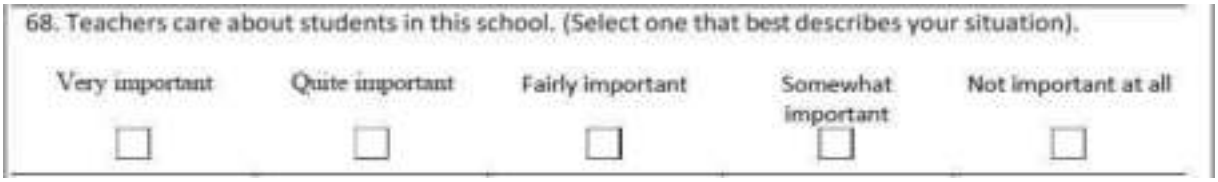
67. Teachers talk to students like me about going to college. (Select one that best describes your situation).

Very important ☐ Quite important ☐ Fairly important ☐ Somewhat important ☐ Not important at all ☐

Teachers talk to students like me about going to college × In which country is your school located

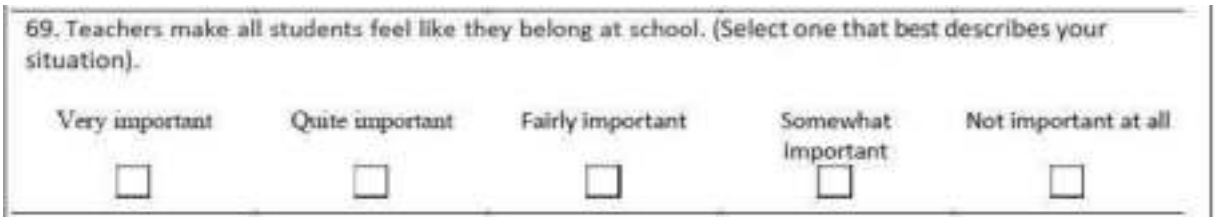
				In which country is your school located		
				South Africa	Singapore	Total
Teachers talk to students like me about going to college	Very important	Count		13	56	69
		Row %		18.8%	81.2%	100.0%
		Column %		14.6%	70.0%	40.8%
		Total %		7.7%	33.1%	40.8%
	Quite important	Count		49	24	73
		Row %		67.1%	32.9%	100.0%
		Column %		55.1%	30.0%	43.2%
		Total %		29.0%	14.2%	43.2%
		%				
		Total %		13.0%	0.0%	13.0%
	Somewhat important	Count		1	0	1
		Row %		100.0%	0.0%	100.0%
		Column %		1.1%	0.0%	0.6%
		Total %		0.6%	0.0%	0.6%
	Not important at all	Row	nt %	4	0	4
				100.0%	0.0%	100.0%

		Column %	4.5%	0.0%	2.4%
		Total %	2.4%	0.0%	2.4%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



Teachers care about students in this school × In which country is your school located

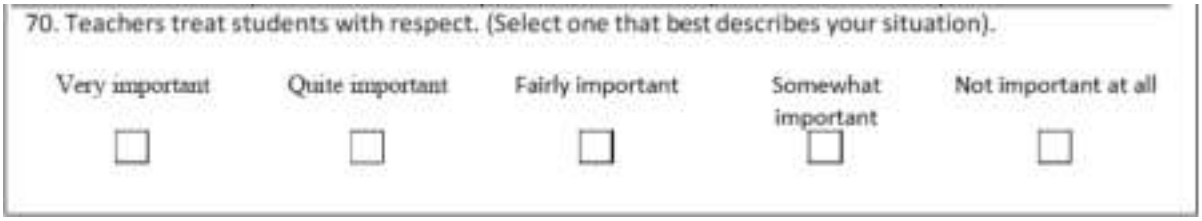
				In which country is your school located		
				South Africa	Singapore	Total
Teachers care about students in this school	Very important	Count		17	50	67
		Row %		25.4%	74.6%	100.0%
		Column %		19.1%	62.5%	39.6%
		Total %		10.1%	29.6%	39.6%
	Quite important	Count		47	30	77
		Row %		61.0%	39.0%	100.0%
		Column %		52.8%	37.5%	45.6%
		Total %		27.8%	17.8%	45.6%
	Fairly important	Count		21	0	21
		Row %		100.0%	0.0%	100.0%
		Column %		23.6%	0.0%	12.4%
		Total %		12.4%	0.0%	12.4%
	Not important at all	Count		4	0	4
		Row %		100.0%	0.0%	100.0%
		Column %		4.5%	0.0%	2.4%
		Total %		2.4%	0.0%	2.4%
Total		Count		89	80	169
		Row %		52.7%	47.3%	100.0%
		Column %		100.0%	100.0%	100.0%
		Total %		52.7%	47.3%	100.0%


69. Teachers make all students feel like they belong at school. (Select one that best describes your situation).

Very important ☐ Quite important ☐ Fairly important ☐ Somewhat important ☐ Not important at all ☐

Teachers make all students feel like they belong at school × In which country is your school located

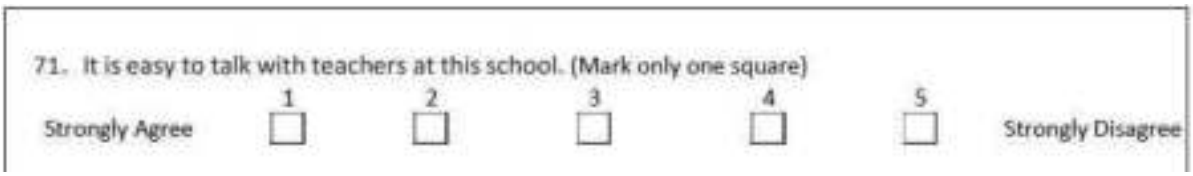
				In which country school located	
				South Africa	Singap
Teachers make all students feel like they belong at school	Very important	Count		16	
		Row %		27.1%	
		Column %		18.0%	
		Total %		9.5%	
	Quite important	Count		46	
		Row %		55.4%	
		Column %		51.7%	
		Total %		27.2%	
	Fairly important	Count		23	
		Row %		100.0%	
		Column %		25.8%	
		Total %		13.6%	
	Not important at all	Count		4	
		Row %		100.0%	
		Column %		4.5%	
		Total %		2.4%	
Total		Count		89	
		Row %		52.7%	4
		Column %		100.0%	1 0
		Total %		52.7%	4


70. Teachers treat students with respect. (Select one that best describes your situation).

Very important	Quite important	Fairly important	Somewhat important	Not important at all
☐	☐	☐	☐	☐

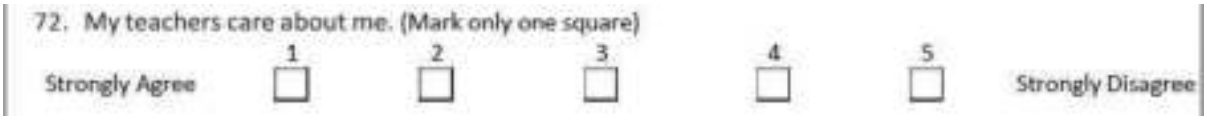
Teachers treat students with respect × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
Teachers treat students with respect	Very important	Count	23	42	65
		Row %	35.4%	64.6%	100.0%
		Column %	25.8%	52.5%	38.5%
		Total %	13.6%	24.9%	38.5%
	Quite important	Count	35	38	73
		Row %	47.9%	52.1%	100.0%
		Column %	39.3%	47.5%	43.2%
		Total %	20.7%	22.5%	43.2%
	Fairly important	Count	24	0	24
		Row %	100.0%	0.0%	100.0%
		Column %	27.0%	0.0%	14.2%
		Total %	14.2%	0.0%	14.2%
	Not important at all	Count	4	0	4
		Row %	100.0%	0.0%	100.0%
		Column %	4.5%	0.0%	2.4%
		Total %	2.4%	0.0%	2.4%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



It is easy to talk with teachers at this school × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
It is easy to talk with teachers at this school	Strongly agree	Count	6	44	50
		Row %	12.0%	88.0%	100.0%
		Column %	6.7%	55.0%	29.6%
		Total %	3.6%	26.0%	29.6%
	Agree	Count	44	35	79
		Row %	55.7%	44.3%	100.0%
		Column %	49.4%	43.8%	46.7%
		Total %	26.0%	20.7%	46.7%
	Not sure	Count	31	1	32
		Row %	96.9%	3.1%	100.0%
		Column %	34.8%	1.3%	18.9%
		Total %	18.3%	0.6%	18.9%
	Disagree	Count	3	0	3
		Row %	100.0%	0.0%	100.0%
		Column %	3.4%	0.0%	1.8%
		Total %	1.8%	0.0%	1.8%
	Strongly disagree	Count	5	0	5
		Row %	100.0%	0.0%	100.0%
		Column %	5.6%	0.0%	3.0%
		Total %	3.0%	0.0%	3.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



My teachers care about me × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
My teachers care about me	Strongly agree	Count	21	58	79

		Row %	26.6%	73.4%	100.0%
		Column %	23.6%	72.5%	46.7%
		Total %	12.4%	34.3%	46.7%
	Agree	Count	36	22	58
		Row %	62.1%	37.9%	100.0%
		Column %	40.4%	27.5%	34.3%
		Total %	21.3%	13.0%	34.3%
	Not sure	Count	25	0	25
		Row %	100.0%	0.0%	100.0%
		Column %	28.1%	0.0%	14.8%
		Total %	14.8%	0.0%	14.8%
	Disagree	Count	2	0	2
		Row %	100.0%	0.0%	100.0%
		Column %	2.2%	0.0%	1.2%
		Total %	1.2%	0.0%	1.2%
	Strongly disagree	Count	5	0	5
		Row %	100.0%	0.0%	100.0%
		Column %	5.6%	0.0%	3.0%
		Total %	3.0%	0.0%	3.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%

73. My teachers make me feel good about myself. (Mark only one square)

Strongly Agree	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	Strongly Disagree

My teachers make me feel good about myself × In which country is your school located

		In which country is yo	
		South Africa	Sir
My teachers make me feel good about	Strongly agree	8	

myself		Count		14.3%
		Row %		9.0%
		Column %		4.7%
		Total %		
	Agree	Count	47	
		Row %	59.5%	
		Column %	52.8%	
		Total %	27.8%	
	Not sure	Count	26	
		Row %	100.0%	
		Column %	29.2%	
		Total %	15.4%	
	Disagree	Count	3	
		Row %	100.0%	
		Column %	3.4%	
		Total %	1.8%	
	Strongly disagree	Count	5	
		Row %	100.0%	
		Column %	5.6%	
		Total %	3.0%	
Total		Count	89	
		Row %	52.7%	4
		Column %	100.0%	10
		Total %	52.7%	4

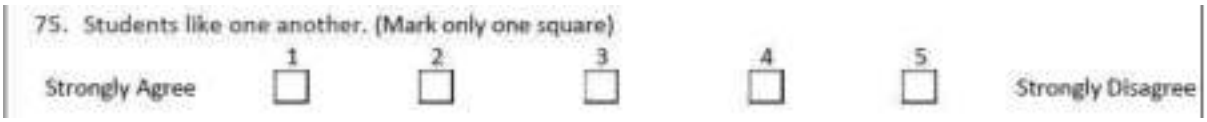
74. Students respect one another. (Mark only one square)

Strongly Agree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly Disagree

Students respect one another × In which country is your school located

			In which country is your school loca ted		Total
			South Africa	Singapore	
Students respect one another	Strongly agree	Count	19	56	75
		Row %	25.3%	74.7%	100.0%
		Column %	21.3%	70.0%	44.4%
		Total %	11.2%	33.1%	44.4%
	Agree	Count	39	24	63
		Row %	61.9%	38.1%	100.0%

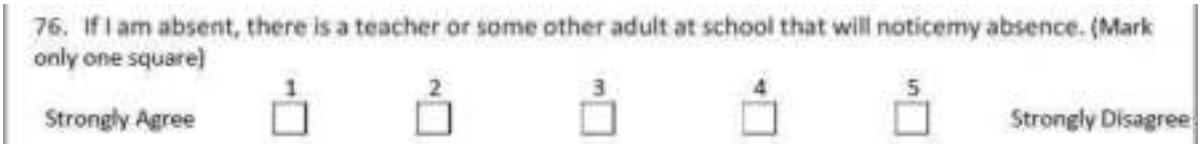
		Column %	43.8%	30.0%	37.3%
		Total %	23.1%	14.2%	37.3%
	Not sure	Count	24	0	24
		Row %	100.0%	0.0%	100.0%
		Column %	27.0%	0.0%	14.2%
		Total %	14.2%	0.0%	14.2%
	Disagree	Count	2	0	2
		Row %	100.0%	0.0%	100.0%
		Column %	2.2%	0.0%	1.2%
		Total %	1.2%	0.0%	1.2%
	Strongly disagree	Count	5	0	5
		Row %	100.0%	0.0%	100.0%
		Column %	5.6%	0.0%	3.0%
		Total %	3.0%	0.0%	3.0%
Total		Count	89	80	169
		Row %	52.70%	47.30%	100.0%
		Column %	100.00%	100.00%	100.0%
		Total %	52.70%	47.30%	100.0%



Students like one another × In which country is your school located

			In which country is your school loca ted		Total
			South Africa	Singapore	
Students like one another	Strongly agree	Count	8	49	57
		Row %	14.0%	86.0%	100.0%
		Column %	9.0%	61.3%	33.7%
		Total %	4.7%	29.0%	33.7%
	Agree	Count	44	31	75
		Row %	58.7%	41.3%	100.0%
		Column %	49.4%	38.8%	44.4%
		Total %	26.0%	18.3%	44.4%
	Not sure	Count	29	0	29
		Row %	100.0%	0.0%	100.0%
		Column %	32.6%	0.0%	17.2%
		Total %	17.2%	0.0%	17.2%
	Disagree	Count	3	0	3

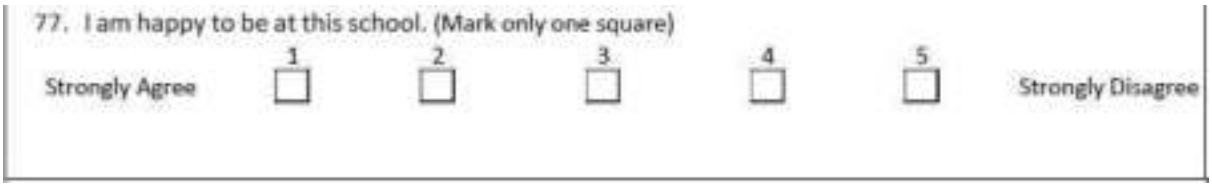
		Row %	100.0%	0.0%	100.0%
		Column %	3.4%	0.0%	1.8%
		Total %	1.8%	0.0%	1.8%
	Strongly disagree	Count	5	0	5
		Row %	100.0%	0.0%	100.0%
		Column %	5.6%	0.0%	3.0%
		Total %	3.0%	0.0%	3.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



If I am absent, there is a teacher or some other adult at school that will notice my absence × In which country is your school located

			In which country is your school located		
			South Africa	Singapore	Total
If I am absent, there is a teacher or some other adult at school that will notice my absence	Strongly agree	Count	20	61	81
		Row %	24.7%	75.3%	100.0%
		Column %	22.5%	76.3%	47.9%
		Total %	11.8%	36.1%	47.9%
	Agree	Count	43	19	62
		Row %	69.4%	30.6%	100.0%
		Column %	48.3%	23.8%	36.7%
		Total %	25.4%	11.2%	36.7%
	Not sure	Count	19	0	19
		Row %	100.0%	0.0%	100.0%
		Column %	21.3%	0.0%	11.2%
		Total %	11.2%	0.0%	11.2%
	Disagree	Count	2	0	2
		Row %	100.0%	0.0%	100.0%
		Column %			
		Total %			

	Strongly disagree	Count	5	0	5
		Row %	100.0%	0.0%	100.0%
		Column %	5.6%	0.0%	3.0%
		Total %	3.0%	0.0%	3.0%
Total		Count	89	80	169
		Row %	52.7%	47.3%	100.0%
		Column %	100.0%	100.0%	100.0%
		Total %	52.7%	47.3%	100.0%



I am happy to be at this school × In which country is your school located

			In which country is your school located		Total
			South Africa	Singapore	
I am happy to be at this school	Strongly agree	Count	9	56	65
		Row %	13.80%	86.20%	100.00%
		Column %	10.10%	70.00%	38.50%
		Total %	5.30%	33.10%	38.50%
	Agree	Count	67	24	91
		Row %	73.60%	26.40%	100.00%
		Column %	75.3%	30.0%	53.8%
		Total %	39.6%	14.2%	53.8%
	Not sure	Count	10	0	10
		Row %	100.0%	0.0%	100.0%
		Column %	11.2%	0.0%	5.9%
		Total %	5.9%	0.0%	5.9%
	Disagree	Count	1	0	1
		Row %	100.0%	0.0%	100.0%
		Column %	1.1%	0.0%	0.6%
		Total %	0.6%	0.0%	0.6%
	Strongly disagree	Count	2	0	2
		Row %	100.0%	0.0%	100.0%
		Column %	2.2%	0.0%	1.2%
		Total %	1.2%	0.0%	1.2%

Total	Count	89	80	169
	Row %	52.7%	47.3%	100.0%
	Column %	100.0%	100.0%	100.0%
	Total %	52.7%	47.3%	100.0%

Appendix S: Literature Matrix Used

Literature-Review-Management-Templ