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Department of Mathematics and Information Technology

Bachelor of Education (Honours) (Primary) - Mathematics

Mathematics Textbook Analysis: Effectiveness on promoting curricula aim of International Baccalaureate and New Senior Secondary

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Declaration

I, Yiu Tung Hei Raphael , declare that this research report represents my own work under the supervision of Associate Professor Dr. Cheng Kell Hiu Fai, and that it has not been submitted previously for examination to any tertiary institution.

Signed _____

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May 7, 2020

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Abstract

Local curriculum restructured, mostly affected the admission of University. Students no longer take two examinations, Hong Kong Certificate Education Examination (HKCEE) and Hong

Kong Advanced Level Examination (HKALE) as an admission ticket to the University. However, a three year senior secondary educational scheme, the New Senior Secondary (NSS) was introduced by the Education Bureau as a policy. At the meantime, a worldwide recognized curriculum slowly influencing the new educational state in Hong Kong, the International Baccalaureate Diploma Programme (IBDP). Both NSS and IBDP act as a major University admission threshold, numbers of attendants, was having a massive difference at the beginning, due to the numbers of schools provide IBDP is limited to international schools, while every local secondary school are providing the NSS. Trends changed in the 2010s, more international schools were operating, and more students demanded to take the IBDP, some local schools with better capital and resources decided to implement a dual-school system, which operates both IBDP and NSS at the same time. NSS and IBDP are frequently compared nowadays since their curriculum resembles each other and discussion were always held such as which curriculum is better than the other

This study aimed to talk about mathematics textbook effectiveness of both curricula in promoting respective curricula intended aim and the intended aim of their mathematics course; the second aim of the study is to use the mathematics textbook perspective to speculate whether IBDP is a better curriculum than the NSS. The study is conducted by comparing two textbooks which are acknowledged by their respective official organization and examining the items included in the textbooks. The study founded that IB's textbook is not educational friendly and not promoting the aim effectively. NSS textbook is more completed and user-friendly, while successfully fulfil and contain the content that corresponds to the curriculum aim and mathematics educational aim. Interpretation and suggestions will be made at the end of the study.

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1. Introduction

1.2 Background

Currently, in Hong Kong, tertiary education majorly admits students under two kinds of the curriculum by default. First and foremost, it would be the HKDSE examination, since the education reform was introduced in 2004, the senior secondary education

curriculum and undergraduate study have changed to a new format, and the duration was reformed, well known as '334' (Education Bureau, 2000). In 2018, there was 59000 candidates took part in the HKDSE examination (HKEAA, 2018) including the students coming from the registered day school and some private sectors; which was the vast majority of Universities freshman in the fall of 2018. The other senior secondary curriculum is the International Baccalaureate examination. In 2018, there were 2285 candidates attended the exam organized by the International Baccalaureate Organization (IBO, 2018).

By comparison, the number of candidates that attended the IB examination is significantly less than the number of people that attended the HKDSE. Although the number is in colossal difference, looking back to the statistics in 2016 for both HKDSE examination and the IB examination, it is clear that the HKDSE is undergoing a decline of participants throughout the years, from 68128 (HKEAA, 2016) to 59000 (HKEAA, 2018). Alternatively, the IBO has recorded an increasing trend of students attending the IBO examination, in 2016, there was 2072 candidate (while 965 of them are having 'Hong Kong as their first nationality). Moreover, in 2018, 2285 students were recorded taking the IB exams in Hong Kong under the schools offering IB curriculum, and 1054 of them are having the Hong Kong identity card. It was apparent that the number of people enrolling the IB curriculum is increasing despite that the amount is not drastic. Adversely, the number of students that attend the HKDSE examination are dropping sharply.

It is achievable to the conclusion that the IB curriculum is slowly implementing to the Hong Kong education system. In 2010 of Hong Kong, only six schools regulated by the English School Foundation (well-known as ESF) were offering IB diploma program (W. Bosberry-Scott, 2010), and 32 high schools are offering IB diploma program to Hong Kong students currently (IBO, 2019). While part of them are not even funded by the ESF and invest a large amount of capital to startup a distinctive curriculum and stand out the educational environment to their students, such as St Paul's Co-educational College and Diocesan Boys' School. The schools described above are utilizing a 'dual school system', apart from vocational training like the Germany education system. Schools that working within the 'dual school system' are schools that offer both New senior secondary academic structure and the International Baccalaureate Diploma Program (IBDP) within the same campus.

Using the example of Diocesan Boys' school, the school decided to unify all the students to take the regular junior secondary curriculum for the first three years (f.1 -

f.3) and let the students choose between the NSS and the IBDP. Although the IBDP originally is a 2-year curriculum, the Diocesan Boys' school decided to insert a 'pre-IB' program to act as a preliminary part of the IBDP, and to suits the NSS 3 year program. Students in the IBDP have to choose from 3 kinds of mathematics curriculum; they are Math Studies, Math Standard Level (SL) and Math Higher Level (HL). Different IBDP mathematics curriculum serves a different purpose and consists of different topics and difficulty, as the higher level is the hardest and math studies is the easiest among the three. Student chosen IBDP have to choose one among the three.

Similarly, the NSS mathematics curriculum is required as a core subject (Education Bureau, 2000), which is a compulsory subject for every participant, alongside with English, Chinese and liberal studies. Additionally, students can voluntary choose to enroll in an extended part of mathematics, module 1 or module 2, with a completely different context, as a new subject. The IBDP examination would rate students from 0-7, while 7 act as highest and in the HKDSE examination, they also serve a 7-mark system, which 6 and 7 are substituted as 5* and 5** respectively, additionally, the HKDSE 5* and 5** are measured through norm referencing, while the whole IBDP is curved based.

In Hong Kong, the IBDP is usually referred as the better curriculum as the university admission rate is way higher than the NSS, this is due to the difference of curriculum, the IBDP usually rely more on continuous assessment, and the school work is usually school-based and adjudicated by school teachers. Adversely, the NSS curriculum is a one-off exam; students usually cramped for the exam and to compete for a better prospect. Continuous assessment is practical towards science education (B. Bell, B. Cowie 2001). Therefore, even the Education Bureau decided to implement 'School-based assessment' for NSS students, to act as a formative assessment to students, while reducing the importance and stress of the one-off HKDSE examination. Science, English, Chinese Liberal studies all included except mathematics. Differently, the IBDP hugely promote formative assessment, they provide a large amount of school work to act as continuous assessment, even in mathematics.

1.3 Research Aim

Mathematics acts an essential role for students as it enhances their logical thinking and problem-solving skills. Students with better logical thinking and problem-solving ability tend to contribute more to society. Better logical thinking can act as research purpose and enhance our quality of life, while better problem-solving skills will help a

person to handle hardships. Two curricula, IB and NSS, represents a global curriculum and local curriculum respectively, act as an entrance of university admission in Hong Kong shares a mandatory subject, Mathematics.

As a teacher-to-be and the personal interest into curriculum and mathematics education, and also having an alma mater of a ‘dual school system’; it is crucial that to research this controversial issue of the two primary curricula in Hong Kong. Within so many potential problems to target and tackle, in the first hand, this research is planned to focus on mathematics education specifically, however, instead of learner-based or case study, textbook of both curricula will be investigated in the research.

Since in Hong Kong, only the more resourceful schools (such as school under ESF) and students can take the IB curriculum, and the IBO, who regulated the IBDP schools are having high standards on the facilities and program requirement of the IB schools. Therefore, the school fees that came from hiring IBO-recognized teachers, and up to standard school facilities, are naturally translated to the students (or their parents), since the HKSAR government does not subsidise much since they have to focus on the local secondary school curriculum. At the same time, the IBO requires schools to pay an annual registration fee and teachers to attend workshops, to keep up with the global perspective and interest, besides, to learn more about the classroom techniques (E Yau, 2015). To sum up, the school fees with be significantly higher than their counterparts. Thus, not much school are affordable to switch to the IBDP.

By facilitating the network of the International Baccalaureate Organization, students of the IBDP are having an extremely high chance of having getting admitted to the university, unlike the HKDSE and JUPAS. This resulted that the IBDP in Hong Kong are regarded as the more superior curriculum in Hong Kong, and many students who are affordable to it will turn their eyes to it and leave the NSS curriculum since they are recognized as an exam-oriented curriculum.

There is a lot of comparison between the curricula throughout the years since the two curricula cannot be compared directly. As more people are choosing IB and NSS, this research act as an aim of seeking an answer on the superiority between IB and NSS, and evaluate whether people switching from the NSS to the IB is an educationally wise option. Between 2 curriculum, many aspects could be used as a comparison. Teaching material is chosen in this study because of 2 reasons. The first reason would be the importance of textbook. Hong Kong education system relies heavily on the textbook, while the IBDP is relatively lesser, this would suggest a huge difference and possibly

explain the difference between the two curricula to a certain extent. The second reason is that teaching material is a traceable source of information, while used by every student and both curricula required. By this reason, two curricula could be assessed relatively under a reasonable standard and supported by concrete evidence.

This research will mainly focus on the difference between the two mathematics curriculum and the supporting teaching material. The purpose is to see whether one of them is a better mathematics curriculum through their textbook and teaching materials, does it suit the aim of their curriculum and being a more superior curriculum through their teaching materials.

1.4 Research Question

Within the research aim, create a more precise objective for the research could create a more efficient proposal for the research design. Through the mentioned listed problem in the 'research aim', we can choose a few and combine them to be the critical question we are asking through the research period.

1. Are the IBDP generally better than the NSS mathematics curriculum in teaching materials?

2. Does the teaching material (generally used by the public) effectively fulfill the aims of the respective mathematics curriculum.

By putting these questions as to the critical objective, the research could be designed and plan a suitable research method to explore the answer to the research question.

1.5 Definition

The curriculum in this study is International Baccalaureate Diploma Programme (IBDP) which is a two-year curriculum, organised by IBO and Hong Kong New Senior Secondary (NSS) Curriculum which is a three-year curriculum organised by EDB. IBDP is having three kinds of courses structure, math studies, standard level and high level; students have to choose 1 of them in the two-year curriculum; The NSS have compulsory core subject, students can also choose the extended part M1 and M2 as an elective subject. This research is to focus on the performance of students in logical

thinking skills and problem-solving ability during their learning experience. Logical thinking and problem-solving skills are defined as the process in which one uses reasoning to conclude or to solve a problem with a reasonable approach.

The mission of IBDP is to develop inquiring, knowledgeable and caring young people through understanding and respect, which also promotes lifelong learning, becoming active and compassionate. The learning goals of the NSS is to acquire a broad knowledge base, acquire IT and other skills for being a lifelong learner and understand one's aspirations (Cheung 2010).

2. Literature Review

2.1 Reasons behind the decision of choosing the Curriculum

Students choosing different curriculum will affect their view towards mathematics and its nature (Koo, 2015). A research done by M.Y. Koo in 2015 about the factors affecting the stakeholders (parents and school authorities) of choosing their children or school respectively was inspiring. In the research, it demonstrates how the students see mathematics during their education curriculum and also what does the teacher thinks about the curriculum. In the aspect of students, a large portion of HKDSE students who only participate in the core part thinks maths is all about calculation and drilling, while the ones who participated in the extended module (M1/M2) will tend to reason and understanding while a few of them think of it is a basic knowledge that could be applied on to different aspects, such as physics and chemistry. For the students who took the IBDP standard level or high level of mathematics, they said due to TOK (a compulsory part of IBDP, which is about the theory of knowledge) they think math is the basis of different theories. It is both arts and science, while it can also show 'how things happen' in a logical way, which means mathematics can be used as an explanation towards the different issue. By this point of view, IBDP students had a mathematics curriculum with more logically oriented. However, teachers in the research showed that teachers tend to think NSS mathematics was a better choice, they highlighted that the NSS curriculum is a curriculum that shows the rigidity of mathematics, students will be more able to understand the nature of mathematics and know-how mathematics developed.

Through reforms in the education field, the NSS did study the IBDP curriculum and learn from it. (徐慧新, 項亞光 2015) (Gibbs, Penelope. 2004) Therefore, similarities could be spotted in between them. However, there are usually more topics covered in

the IBDP while HKDSE is having less topic getting covered, but each topic is more in-depth than the IBDP, students who participated on the M1 or M2 are usually more eager in mathematics, so they do not have negative feedback. Instead, students that only enrolled on the core subject are thinking of it as too complicated and too much drilling in the curriculum. While the feedback from the IBDP students, no matter SL or HL, are all positive as the curriculum was using a more applicable approach, which trains students in a philosophical approach. IBDP mathematics require the student to do exploration. Instead, Lisa Tsui (1999) finds that writing assignments and instructor feedback can have positive development on students' critical thinking skills, which is included in the IBDP mathematics education curriculum. On the other hand, the NSS mathematics curriculum does not have such training, will their critical thinking skills a lot worse than the IBDP students? Is it the case? NSS students can also develop critical thinking skills during the process of drilling and understanding the teacher's explanation; just the curriculum did not implement it.

2.2 Importance of textbooks to mathematics

Teachers see textbooks as extremely helpful in making clear the learning progressions within-subjects, there remains plenty of professional space for using the textbooks in very different ways (Tim Oats, 2014) Textbooks acted as a media between teachers and students. A textbook is the backbone of education, supported the class to function fluently. Tim Oats published a policy paper about the British educational reform and study on the importance of textbook. His paper compared the efficiency of education of 3 countries, Singapore, Britain and Finland. He collected the usage textbook through the TIMSS surveys and their students' academic results on mathematics and science. Results of the study reported that Finland and Singapore were having better results while Britain resulted relatively poorly. On the usage of textbooks, Finland teachers majorly used textbooks as a basis for instruction, and Singapore teachers used both textbook and worksheet and basis, while Britain teachers take textbooks and worksheets as a supplement only.

Taking textbooks as a fundamental means teachers rely on the textbook will go through it while taking as a supplement stands for a reference. Textbooks advantage can free teachers time from planning the entire lesson; instead, teachers can focus on learner progress and provide holistic support. Focusing on learners' progress facilitates learner-centred studies. Having a textbook could lead students on having a guideline to follow the progress of the lesson, students can revise at home and become an active learner through a useful textbook (Adrian Verspoor 1990). Textbook

transmitted the message on ‘what gets taught’ and ‘how it is taught’ to both teachers and students, it helps formalize education, and the standard is more accessible to follow than omitting a textbook in class. Lastly, textbook is supportive of sensitive and practical approaches to high attainment, high equity and high enjoyment of learning (Tim Oats, 2014).

2.3 The aims and roles of Mathematics education in NSS and IB

In the official documents provided by the EDB, the importance of students learning mathematics was highlighted as follow:

1. Mathematics is a crucial mode of thinking
2. A foundation for the study of other discipline
3. Develop necessary skills for lifelong learning

(The Curriculum Development Council, 2017)

The EDB and Curriculum Development Council highlighted the importance of the thinking process in mathematics. The mathematical mindset included in other discipline (subjects) such as Economics, Physics, Chemistry, Biology etc. Lastly, the importance of mathematic in our daily life. From the official documents, it is evident that mathematics plays an essential part in students learning stages even in the future. It further specified the centre of the framework and the aim of the NSS mathematics curriculum. The aim and critical features that NSS mathematics curriculum should provide are as follows:

Aims:

1. Inquire
2. Reason
3. Communicate
4. Formulate
5. Solve problem mathematically
6. Capability of appreciating the aesthetic nature and cultural aspects of mathematics

And the Central curriculum:

1. Subject knowledge and skills as embodied in the learning units under different strands or areas

2. Generic Skills
3. Positive values and attitudes

(The Curriculum Development Council, 2017)

The documents clearly stated that aim of the mathematics curriculum and has given critical terms that school officials and teachers can follow, which could guide students learning and produce a productive learning environment to students and lead to a prospect future.

The IB aims are listed in their documents, while brief and concrete aims are listed clearly and sharply on their website. The brief aims in the website are as follows:

1. Develop mathematical knowledge, concepts and principal
2. Develop logical, critical and creative thinking
3. Employ and refine their powers of abstraction and generalization

(IBO, 2020)

From the above information, it can be seen as three diverse parts. First, it is about mathematical knowledge, such as some mathematical term and mechanical method. Secondly, the vague skills, but can be developed mentally and required a higher level of understanding and development. Lastly, better ability on abstraction and generalization, which is a set of skills and ability that can be connected to problem-solving and formatting stuff to provide convenience to society. This term is rarely being brought up by in the local curriculum. The IBO has issued a detailed document in 2012 on the Mathematics curriculum, included a precise aim of Group 5, which is mathematics. The aims are as follows:

1. Enjoy mathematics, and develop an appreciation of the elegance and power of mathematics
2. Develop an understanding of the principles and nature of mathematics
3. Communicate clearly and confidently in a variety of contexts
4. Develop logical, critical and creative thinking, and patience and persistence in problem-solving
5. Employ and refine their powers of abstraction and generalization
6. Apply and transfer skills to alternative situations, to other areas of knowledge and to future developments
7. Appreciate how developments in technology and mathematics have influenced each other

8. Appreciate the moral, social and ethical implications arising from the work of mathematicians and the applications of mathematics
9. Appreciate the international dimension in mathematics through an awareness of the universality of mathematics and its multicultural and historical perspectives
10. Appreciate the contribution of mathematics to other disciplines, and as a particular "area of knowledge" in the TOK course

(IBO, 2012)

From the ten fully elaborated aims in the academic documents from the IBO, a tendency can be speculated, four aims out of 10 have used the verb 'appreciate' to evaluate the aim of the programme. It would be safe to say the IBO hopes their students to appreciate mathematics while preserving the skills and knowledge in mathematics from the upper six aims. This can be related to the assessment method of the IB and NSS curricula. Applying formative assessment in IB helps the IBO to promote the idea of appreciating mathematics, such as '10. Appreciate the contribution of mathematics to other disciplines, and as a particular "area of knowledge" in the TOK course.' Students have to write an essay about their thoughts and understandings towards mathematics. Teachers of the schools will provide guidance and grade the student's performance throughout the three years of studies. Conversely, the NSS has applied the summative assessment. Students have to focus on the one-off examination; all of the focuses will be given towards drilling and mechanical solving ability.

2.3 The importance of probability education

Within a curriculum, there are many contents and diverse knowledge, such as NSS, from data handling to 3-D figures, while the IB, from integers to calculus. Topic selection is crucial as it can trim down to a more focused common topic to take comparison carefully, in order to reflect a more meaningful result and tackle the research problem. They were stated in Manfred Borovcnik & Ramesh Kapadia (2009), on mathematics education, about research and development in probability education. They stated the importance of probability being included in mathematics education.

- Misconceptions on probability affect people's decisions in important situations, such as medical tests, jury verdicts, investment, assessment, etc.
- Probability is essential to understand any inferential procedure of statistics.
- Probability offers a tool for modelling and "creating" reality. For example, modern physics cannot be formulated without reference to probability concepts.

- The concepts of risk (not only in financial markets) and reliability are closely related to and dependent upon probability.
- Probability is an interesting subject in its own right and worthy of study.

(Manfred Borovcnik & Ramesh Kapadia, 2009)

The above reasons can be concluded into three reasons generally,

1. Enhancing logic
2. Probability is social and career related
3. A fairly different approach on mathematics that related to life in another way

The above reasons can be concluded into three reasons; generally, reasons, as mentioned earlier, fostered the selection of topic. It is commonly believed that probability is more favourite or less repelled by students since it is related to reality in a closer means, unlike other topics such as trigonometry.

2.4 Factor of choosing curriculum

Three stakeholders are included in choosing the curriculum they are Schools (including school officials and teachers), Students and Parents. Schools consider accreditation the first, which is the acceptance of the diploma. This represents the reason why local schools massively ahead in number, as students vastly would want to take tertiary education in Hong Kong, resources is another factor, including both capital and human resources. IB teachers have a slightly higher standard and requirement, moreover, the facilities for running formative assessment is higher than regular NSS curriculum required. The mission of the curriculum and the ability of students is also in consideration.

For parents, they would consider the willingness of their child, as a learner-centred society, parents are more willing to listen to their children and consider their needs. Family affordability is essential, as IBDP will require higher running cost and school fee is higher than usual.

Students usually consider 2 points. First, it is future studies, as IBDP facilitates overseas studies since it is an international curriculum; while NSS usually being admitted limitedly from Hong Kong or a few universities. 2nd reason is the study mode. Study mode is affected by the assessment method, people with the higher ability to handle stress could get used to summative assessment, while a student who enjoyed learning would be more suitable with the IBDP studying pattern.

3. Methodology

3.1 Research Design

This research will be conducted through qualitative research design and quantitative research. Content analysis will apply to both curriculum textbooks and teaching material. One textbook in each curriculum will be selected to work on both qualitative and quantitative research design. The research will focus on data handling strand of senior secondary for the NSS, and the IBDP will be probability and statistics. Quantitative research design is aimed to obtain a pattern within the curriculum and can be used to compare the two curricula in a more organized way. The textbook that will be chosen as the research data should be used by the schools currently, as frequent or being used by more school as possible.

Content analysis is chosen for this study. Analysis of the body of texts will be made by counting critical features within the topic and textbooks. Data from this study is combined with qualitative and quantitative. Qualitative methods can enable a study to analyze the issue genuinely and comprehensively (Patton, 1990). Quantitative research design can provide an objective view of specific items included in the editing of the textbook. Content analysis is defined as a subjective research method based on interpretation of the text data through the systematic classification process of coding and identifying themes or patterns (Hsieh & Shannon, 2005, p. 1278). Content analysis will produce valid assumption from the content to the context (Krippendorff, 2004) and it is possible to assume the meaning of the sender, the message and the receiver (Weber, 1990). The limitation is followed by the decision of using content analysis as the core research method of this study. Personal inference on the qualitative research of the context of the textbook might not wholly reflect the actual state of education and cater every case in the application of the textbook. Quantitative content research requires particularly reasonable assumption based on objective results and counting. Assumption and subjective interpretation are vital to this textbook analysis to obtain a consistent result.

3.2 Choices of textbook

One textbook from each curriculum is chosen to conduct the textbook analysis. The detail of the book is as follows:

IBDP:

Name of the book: MATHEMATIS STANDARD LEVEL for the IB Diploma

Year of publishing: 2004

Author: Robert Smedley and Garry Wiseman

Consultant: Colin Jeavons and Sheila Messer

Publisher: OXFORD UNIVERSITY PRESS

NSS:

Name of the book: Mathematics in Focus (Book E) (Compulsory Part)

Year of publishing: 2010

Author: Hung Chun Wah, Chu Wing Cheong, Mak Kwok Cheung and Chan Kwok Kwan

Reviewers: Chua Doi Eng. Chung Ting Kai, Hung Wai Sing, Lo Yin Kue, Ng Kwok Fai and Shum Cheong

Consultant: Wong Ka Ming

Publisher: Educational Publishing House Limited

The reasons for choosing the two textbooks from the curriculum are their accreditation. First and foremost, the IB textbook that was chosen is from The OXFORD UNIVERSITY PRESS; the OXFORD UNIVERSITY PRESS is being listed as one of the co-publisher. This means the OXFORD UNIVERSITY PRESS products labelled as IB are guaranteed by the IBO on quality and standardization. The NSS, textbook that was chosen is from the Educational Publishing House; its advantage was being listed clearly on the website of EDB in the recommended textbook list. 'Mathematics in Focus' was graded by the EDB with the following comments:

- Core elements of the subject curriculum dealt with appropriately in general

- Clear concepts relevant use of data and information in general
- Organisation of content and development of concepts appropriate and logical
- Generally appropriate learning activities provided to facilitate the achievement of targets
- Accurate language

(Textbook Committee, Education Bureau 2019)

From the details that are enclosed, NSS is having higher transparency on textbook regulations and recommendations, yet EDB disclosed the advantage of the individual textbook and supplemented with comments.

3.3 Selection of Topic

The topic being selected is PROBABILITY. The reason behind is the importance of probability to students and learning progression, while probability is an essential linkage between mathematics, students and daily action. More reasons are listed in 2 Literature Review – 2.3 The Importance of Probability Education.

3.4 Investigated Area

In REYHAN SAĞLAM 2012 master's thesis, ten areas can be investigated when textbook analysis and comparison is being made.

1. External position of the chapter
2. Internal content
3. Internal organization
4. General organization
5. Student centered activities
6. Topic explanation
7. Real-life connections
8. Uses of technologies
9. Problems and exercise
10. Historical Notes

(REYHAN SAĞLAM 2012)

This study will share the same areas with the relatable master thesis. However, some areas are not compatible with the study. The details of each area will be discussed in the '4. Result' individually.

4. Results

The result will be based on the ten criteria as mentioned earlier and used to address the research question.

1. Are the IBDP generally better than the NSS mathematics curriculum inteaching materials
2. Does the teaching material (generally used by the public) effectively fulfilll the aims of the respective mathematics curriculum

4.1 External position of the chapter

The external position of the chapter stands for the physical placement and features that the chapter is included in the textbook. This study will investigate from the placement, such as the chapter before and after 'Probability', which stands for the composition of knowledge and curriculum suggested by the textbook. The second component is the weight of the chapter; it stands for the pages and the suggested time allocation.

NSS:

19	Permutation and Combination
20	**Probability**
21	Measures and Dispersion
22	Uses and Abuses of Statistics

IB:

13	Vector

14	**Probability**
15	Statistics

	NSS	IB
Pages of the Chapter (Total)	P.53 - P.116 (64)	P.367 - P.383 (17)
Pages of the Book	280 pages	472 pages
Percentage (pages)	22.9% (to 3 s.f.) (4.57%)	3.60% (to 3 s.f.)
Duration (duration of the whole mathematics curriculum)	10 (250) hours (39 if including statistics)	35 (150) hours *time suggestion has included statistics
Percentage (duration)	15.6%	23.3% (to 3 s.f.)

From the above-listed datum, it is safe to make logical inference about the position and weight of the chapter. Both textbooks placed the chapter at the end of the book or series of the book. First of all, in the IB, OXFORD UNIVERSITY PRESS uses one book to conclude the two-year basis mathematics curriculum and placing the chapter as the second last topic. NSS did it similarly, which suggested that the topic 'PROBABILITY' require advanced knowledge and logical thinking. Moreover, school-based curriculum always switches topics around to cater to school policy. However, the probability is usually placed in the latter stages of learning, such as the end of S5 or the beginning of S6. The relation of probability to other topics, which is commonly stated as 'co-relation', are relatively weaker than the others. For example, polygons facilitate the learning of circles, and equation facilitates the learning of graph and calculus. Conversely, the probability is relatively having less connection with others, except statistics.

The chapter ‘Statistics’ is used like the following chapter of ‘Probability’ in both curricula, shows the relationship between them. Learning probability is the introduction of the usage of statistics, while statistics are hugely related to society and social science. The NSS placed ‘Permutation and Combination’ (P&C) right before the chapter ‘Probability’. P&C is a part in the probability or taken as the start of probability usually since counting is the beginning of probability. The arrangement made by the NSS book is benefitting weaker students as students get a more comfortable start from learning probability. IBDP chooses ‘Vector’ which shows a few relationships with the probability.

By the percentage listed in the table, it is evident that the textbook content in the books are similar, differ by 1% only. The topic size is the same, but the NSS is using a lot more pages than the IBDP book. The suggested duration suggested that IB tends to take more time on educating probability than the NSS.

4.2 Internal Content

Internal content research is majorly quantitative. It is counting the chapter’s learning outcome.

Table 4.2.1

	NSS	IB
Set language	✓	✓
Venn Diagram	✓	✓
Conditional probability	✓	✓
Mutually exclusive / complementary events	✓	✓
Multiplication Rule	✓	

Permutation and Combination	✓	
Expected outcome		✓
Replacement		✓

NSS textbook:

Table 4.2.2

20.1	Set language
20.2	Addition Law of Probability
20.3	Multiplication Law of Probability
20.4	Solving Problems Relating to Probability by Using Permutation and Combination

IBDP textbook:

Table 4.2.3

6.5	Concepts of trial, outcome, equally likely outcomes, sample space (U) and event
6.6	Combines events
6.7	Conditional Probability and independent events
6.8	Use of Venn Diagrams, tree diagrams and tables of outcomes to solve problems

The data are collected in the respective curricula document. The learning outcome of both curricula is basically identical and repetitive, and not much could speculate here. The NSS textbook followed the curriculum instructions closely while the IBDP textbook didn't; the education document of the IBDP suggested that the statistics should start first, but the book compiled the other way round and switch its internal organization.

4.3 Internal Organization

The internal organization focuses on the structure of the chapter, which is qualitative. It is an aspect of inspecting the linkage between mathematical concepts and different parts within the textbook.

The internal organization of NSS textbook:

Getting ready
Preview
- Basic knowledge
- warm up exercises

20.1 Set language
- Set notation and Venn Diagram
  - Class exercise A
  - Class exercise B
- Operations On Sets
  - Class exercise C
- Set Notation in Probability
- Exercise 20.1

20.2 Addition Law of Probability
- Mutually Exclusive Events
  - Class Exercise A
- The Addition Law of Probability
  - Class Activity
  - Examples
  - Class Exercise B
- Complementary Events
  - Class Exercise C
  - Examples
- Exercise 20.2

20.3 Multiplication Law of Probability

- Independent Events
  - Class Activity A
  - Examples
- Conditional Probability
  - Class Activity B
  - Examples
- Dependent Events
  - Class Exercise A
  - Class Activity C
  - Examples
  - Class Exercise B
- Exercise 20.3

20.4 Solving Problems Relating to Probability by Using Permutation and Combination

- Examples
- Exercise 20.4

Chapter Summary

Concept Connection

True or False

Revision Exercise 20

- Public Examination Questions
- Investigative Task

The internal organization of IB textbook

14 Probability

- A clear list of content
- Examples

14.1 Combined Events

- Playing cards
  - Examples
- Mutually exclusive events
  - Examples
- Exhaustive events

- Examples
- Complementary events
  - Examples

Exercise 14A

14.2 Conditional Probability

- Independence
  - Examples
- Tree Diagrams
  - Examples
- Exercise 14B

Summary

Revision Exercise 14

The above flow can be translated to a table of content flow and mathematical term sequences.

Content flow

IB	NSS
Content list with formula Definition Worked examples Definition of another content Worked examples Exercise Another subtopic Definition Worked examples Definition of another content Worked examples Exercise	Definition Warm up (activity) Definition Examples Exercise Definition ・ ・ Activity ・ ・ Definition Examples Exercise

Exercise for the Topic	Summary Exercise for the chapter

Mathematical Term

IB	NSS
1. Event 2. Probability 3. Combined events 4. Mutually exclusive events 5. Exhaustive events 6. Complementary events 7. Conditional probability 8. Tree diagram	1. Probability 2. Permutation 3. Combination 4. Set notation and Venn Diagram 5. Set notation in Probability 6. Mutually Exclusive events 7. Addition Law of probability 8. Complementary Events 9. Multiplication Law 10. Independent event 11. Conditional probability 12. Dependent event

IB is packed with content and definition, and followed exercise after a few key features or definitions; the NSS alternates between definition, examples and exercise, with a higher frequency of exercise. With the flow of mathematical term, NSS dissected the topic into smaller pieces while the overall size of the topic remains the same. This suggested that NSS textbook are slightly more user-friendly with more frequent exercise. The arrangement coped with the fact that NSS assessment is more mechanically based, then more drilling is required.

4.4 General Organization

This part would be quantitative; it focuses on the content and their respective application. The topic explanations, problem and exercise in the chapter, the percentage of allocation will be presented too. The content can be divided into three parts,

- Topic explanation (Type 1)

- Exercise and problem (Type 2)
- Others (photos, extra information, chapter summary etc) (Type 3)

	IB (%)	NSS (%)
Type 1	9.5 pages (55.9%)	26 pages (40.6%)
Type 2	7.5 pages (44.1%)	34.5 pages (53.9%)
Type 3	0 page (0%)	3.5 pages (5.47%)

From the above data, we can see that the IBDP textbook has a vibrant content, highly focuses on useful content. The NSS textbook os having a slight edge on the percentage of exercise and the IBDP textbook has focused more on explanation and definition. From the table above, it is logical to assume that by having a similar curriculum content, the NSS textbook provided a lot more pages on every aspect. It is safe to speculate that NSS textbook is more comfortable to follow and learn under scaffolding; while the IB requires understandings by providing less content, which means IBDP textbook is a more precise and critical textbook.

4.5 Student Centered Activity

This area is to check the student activity included in the topic, both qualitative and quantitative.

IB	NSS
• Exercise	• 'Getting ready' an activity that intrigue the students • Revision exercise • Class Exercise • Class Activity

Exercise is counted as an activity because students themselves can work it. It is stood out that NSS textbook consisted of a variety of activities. This explains the content size difference of the IB and NSS. NSS included many activities that are introductive and have different approaches to guide students to learn. More diverse activities facilitate students engagement in learning and trigger better motivation. The OBDP textbook suggested that exercise is the most useful activity and promotes content concentration. IBDP textbook is having a more direct approach and provide a moderate amount of exercise to balance out students centred and teacher-centred education.

4.6 Topic Explanation

The topic explanation is qualitative research; it is based on examples and explanation of the textbook applied. NSS textbook has 41 examples in 64 pages of content, while the IBDP textbook has 12 examples in 17 pages. As the number of pages having a vast discrepancy, having a common example per page would give a more straightforward mean for comparison. NSS textbook resulted in 0.641 examples per page, while the IBDP textbook resulted in 0.706 examples per page.

The more examples are used, the easier the student to follow. The results reflected that the difference is not high between the textbooks quantitively..

In the IBDP textbook, the topic explanation will go from ‘Definition’, ‘Mathematical knowledge’ and lastly ‘worked examples’. The IBDP textbook highlighted the key concepts and state the most valuable information of probability at first, then uses an example, which is not a complete mathematical question to clarify the previous information. Lastly, the textbook used worked examples to demonstrate how to solve the problem with a probability directly. The IBDP textbook uses a Venn Diagram on every newly introduced concept, which promotes learning effectively and achieves the aim of learning the outcome of the IBSL mathematics curriculum of learning Venn diagram. Using graph can positively assist the learning of students.

In NSS textbook, the topic explanation will go from ‘Definition’, ‘Exercise/Examples’, ‘Results with mathematical knowledge/exercise’ and ‘Solved problem’. The topic explanation goes from a brief definition, sometimes includes a ‘pre-lesson activity’ to start the topic, which gives students a brief idea on what is happening. Then exercise or examples serves different effects on the topic. Exercise can let students continue the idea from the definition by completing the student activity; examples are to continue the critical ideas by providing good examples. Then Exercise and examples will be followed by ‘Results with mathematical knowledge/exercise’ It follows the previous part and develop the idea by concluding the definition and remind the student

once more. Lastly, the textbook will include a ‘Solved problem’; this can show a solution to let students know how to work on a problem mechanically and provide more examples for further mathematical development. Other than the Venn Diagram, NSS textbook uses more chart and photos to assist the explanation of probability while the Venn diagram is separately introduced. Moreover, supplementary strategy and tricks are put on the side to remind students and helped them on studying; such addition can be used as students; a reminder and facilitates learners’ self-learning ability.

4.7 Real-life connection

This part is measured by both qualitative and quantitative; on measure how the textbook manages to relate life and mathematics to students. Probability is featured as one of the mathematic topics that connect to real-life closely. Every example of both curricula are real-life related; thus no significant and meaningful comparison could be made.

4.8 Uses of Technologies

This part is measured by both qualitative and quantitative, on measuring types of technologies being used to facilitates the learning of students. Both curricula textbooks did not spend extra attention on technologies for the students to learn probability.

4.9 Problem and Exercise

Mathematics Question can be divided into three complexity. (NAEP, 2007) They represent clearly with High, Moderate and Low complexity. Every exercise in the textbook will be recorded and compare.

The Levels are decided by the quality of questions.

Low Complexity includes:

- Recall or recognize a fact, term, or property
- Recognize an example of a concept
- Compute the sum, difference product and Quotient
- Recognize an equivalent representation
- Perform a specified procedure

- Evaluate an expression in an equation or formula for a given variable
- Solve a one-stop word problem
- Draw or measure simple geometric figures
- Retrieve information from a graph, table, or figures

Moderate Complexity includes:

- Represent a situation mathematically in more than one way
- Select and use different representations, depending on situation and purpose
- Solve a word problem requiring multiple steps
- Compare figures and statements
- Provide a justification for steps in a solution process
- Interpret a visual representation
- Extend a pattern
- Retrieve information from a graph, table or figure and use it to solve a problem requiring multiple steps
- Formulate a routine problem, given data and condition
- Interpret a simple argument

High Complexity includes:

- Describe how different representations can be used for different purposes
- Perform a procedure having multiple steps and multiple decision points
- Analyze similarities and differences between procedures and concepts
- Generalize a pattern
- Formulate an original problem, given a situation
- Solve a novel problem
- Solve a problem in more than one way

- Explain and justify a solution to a problem
- Describe, compare, and contrast solution methods
- Formulate a mathematical model for a complex situation
- Analyze the assumptions made in a mathematical model
- Analyze or produce a deductive argument
- Provide a mathematical justification

There are 58 questions in IBDP textbook, can be subsequently into 97 questions, the complexity results are as follow:

Complexity	Number of questions (% among all questions) (to 3 s.f.)
Low	22 (22.7%)
Moderate	72 (74.2%)
High	3 (3.10%)

There are 171 questions in NSS textbook, which can be subsequently into 347 questions, the complexity results are as follow:

Complexity	Number of questions (% among all questions) (to 3 s.f.)
Low	74 (21.3%)
Moderate	269 (77.5%)
High	4 (1.15%)

The difference between the two textbooks is not significant. As expected with the difference of assessment method, NSS textbook is having more exercise, which should be focused more on the moderate or low level. The result produced by the NSS

textbook table is expected as the examination require students to be more mechanically advanced. The IBDP textbook having only 3% of high complexity level, does not match with its curricula aim and expectation..

4.10 Historical Notes

This part is measured by both qualitative and quantitative, on measuring historical information included in notes and its effectiveness. Both curricula did not include any content about probability and its history. It is understandable for the IBDP textbook, as IBDP aimed to be as direct as possible and history content would be excessive for the learner to take extra time to study.

5. Discussion and Suggestion

From the aims of both curricula and the speculation of the ten investigated areas, fulfilment will be made. Out of 10, 5 items in the mathematics curriculum aim are not met, which are:

3. communicate clearly and confidently in a variety of contexts

7. appreciate how developments in technology and mathematics have influenced each other

8. appreciate the moral, social and ethical implications arising from the work of mathematicians and the applications of mathematics

9. appreciate the international dimension in mathematics through an awareness of the universality of mathematics and its multicultural and historical perspectives

10. appreciate the contribution of mathematics to other disciplines, and as a particular "area of knowledge" in the TOK course.

Half of the items are not met by the textbook

For NSS textbooks, only two items are missed, which is 'Appreciate mathematics' and 'positive attitude' By this result, it is fair to say in the perspective of textbooks, NSS textbooks has a better performance. Tackling the research questions, by

textbook performances, IBDP may not be the objectively better than the NSS, as their teaching material provided evidence. The IBDP textbooks did not provide many resources for students and teachers, except exercises and definition, at the same time, NSS textbook provided assorted aids to users.

Throughout the study, it is clear that IBDP textbooks are lacking activity leads to ineffectiveness for students to enjoy, which further leads to ineffectiveness for students to achieve discussion in the aim. Both curricula are missing out historical notes in the textbook, which is believed to enhance students interest. NSS textbook is having a slight edge if it is viewed from the educational perspective, as it uses scaffolding by starting from P&C first. In the end, to conclude both textbooks, specified with 'topic explanation' and 'problem and exercises' can reflect the nature of curricula. IBDP mathematics curriculum focused on the thinking process, and NSS mathematics curriculum focused on problem-solving skills and mechanical drilling. As literature review advised, the selection between curricula should be decided by students study habit and also affordability, since the curriculum are being drafted and designed by different profession. A mathematician designs the IBDP, therefore the curriculum is much straight forward, and fewer aids; NSS are mostly drafted by educator, who caters more education psychology and pedagogy. There is not a definite superiority between curriculum; it is based on personal needs and perspective, it is undeniable that the currently the World benefits more from people got a higher understanding on knowledge (IBDP) instead of mechanically trained up students (NSS), then it explains more about why people are joining IBDP.

6. Limitations

There are limitations in the study, the small sample size of the textbook is being used, if more textbook is being included the data of both curricula will be more concrete and convincing. The judging of complexity was a limitation too, as the author of this study is not a recognized professional educational researcher, the judgment he had made would not be 100% accurate, which affects the percentage of 'problem and exercise' in the investigation and the inferences made in the latter part. Another limitation was the content analysis is hugely based on personal interpretation, which means bias, subjective and pre-assumption is being made, yet the study may not be as accurate and objective. The books that are chosen in the IBDP part is not updated to the utmost curriculum is also a limitation, as the textbook content may be evaluated and edited numerous times within the years.

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Appendix I

Acronyms

NSS - New Senior Secondary

IB - International Baccalaureate

HKDSE - Hong Kong Diploma of Secondary Education

SL - Standard level

IBDP - International Baccalaureate Diploma Programme

IBO – International Baccalaureate Organization

EDB – The Education Bureau

P&C – Permutation and Combination