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Department of Curriculum and Instruction

A Project entitled

An investigation of the effectiveness of exploring STEM through literature in Hong Kong local secondary school setting

Submitted by

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Declaration

I, *Loak Oi Ming* , declare that this research report represents my own work under the supervision of Dr. NG, Cheuk Wing Margaret, and that has not been submitted previously for examination to any tertiary institution.

Signed

Loak Oi Ming
12 April 2022

Abstract

The 15-year-old Hong Kong students' reading, mathematics and sciences performances in PISA dropped in 2018. Also, the Hong Kong students' interest in Mathematics and Science is lower than that in the other areas nearby, like Marco and Shanghai. It is believed that there is a positive relationship between reading and academic performance. Thus, it is vital to increase students' interest in reading STEM literature.

This research aims to investigate the factors that affect junior form students in reading STEM literature, the performance of integration and interpretation skills in reading STEM literature, how reading STEM literature contributes to junior form students' learning in STEM and the changes in attitude towards STEM after reading STEM literature. The purpose of this research is that provide some insights to schools and teachers in discovering the ways to improve students' effectiveness in exploring STEM through literature.

PISA focuses on investigating students' proficiency in applying knowledge to authentic situations while Hong Kong education focuses on training examination and memorization skills. So, in this investigation, it is tried to apply an authentic and problem-solving task in a reading activity.

In this research, it is found that the two most significant factors that make junior form students read STEM literature are the fulfilment of homework requirements, teachers' recommendation and personal interests. The last two shares the same position as the second. Second, the overall performance of reading literacy in STEM literature, focusing on integration and interpretation skills, is satisfactory but diverse. Third, reading STEM literature does not contribute to academic performance explicitly in junior form students' opinions. However, in this investigation, students showed a positive change in attitude towards STEM literature. It is believed that applying authentic and problem-based solving tasks can enable students to link their knowledge to the real world. It is suggested to apply more authentic and problem-based solving tasks in the future. Once students get used to them, they can develop a positive attitude towards STEM literature. The reason is that they find reading worthful and can be applied to day-to-day life. They gain a sense of achievement in the activities. In turn, their academic performance in STEM-related subjects will be improved. Fourth, despite the students' interest in STEM literature increases, they will not spend more time reading STEM literature in the future. The reasons and suggestions are discussed in this research.

Keywords: STEM Education, Reading literacy, Motivation, Interest, authentic task, problem-based solving task

TABLES OF CONTENTS

1. Section 1: Introduction

1.1. Research Background and Significance

Recently, there was an increasing concern about Hong Kong STEM education development. Hong Kong 15-year-old students used to perform well in PISA. In 2012, Hong Kong students' rankings in Science and Reading were in the second position, while the ranking in Mathematics was in the third position among all the regions under investigation (Communication and Public Relation Office, The Chinese University of Hong Kong, 2019). However, there were drops in all aspects in 2018. **Their rankings in Science, Reading and Mathematics decreased to the ninth, fourth and fourth position respectively** (Communication and Public Relation Office, The Chinese University of Hong Kong, 2019).

PISA focuses on investigating students' ability in applying knowledge to authentic life, so the questions asked are closely related to daily life (謝志成和張錦華，2012). PISA science assessment aims to test the scientific investigation skill in an authentic situation, instead of assessing students' memory (麥瑞琪、薛寶嫦、楊文佳和張國祥引，2019). The mode of PISA reading assessment is scenario-based[1], which required different levels of reading and reasoning skills (OCED, 2019). PISA mathematics assessment offers a wide range of contexts in the aspects of problem-solving in a real-world situation in the 21st century (OECD, 2019).

However, the most frequent use of teaching pedagogy in Hong Kong classroom is using public exam questions, like TSA and DSE, or exam questions provided by the publisher to clarify the teaching concept and train students' answering skills (林智中、何瑞珠和曾榮光，2020). Also, the Asian students' ability and preference for memorizing material are higher than learning at a more in-depth level (Dempsey & Litchfield, 2015). In other words, **the learning and teaching method in Hong Kong is highly exam-oriented, which is in the opposite direction of the PISA assessment's focus and the trend of global education development.**

There is a positive relationship between reading and academic performance. Take the relationship between reading literacy and science performance as an example. Students' reading comprehension is closely related to their science performance, good readers usually have a better performance in Science (Cruz Neri, Guill & Retelsdorf, 2019). So, it is crucial to increase students' reading literacy and learning motivation toward STEM education. Based on the PISA results, Hong Kong students' interest in Mathematics and Science is below the global average and other nearby areas like Shanghai and Marco (Fung, Fung, Tai & Tsang, 2017). Interest is an influential

[1] Realistic problems are presented to students to solve.

motivational process that energizes learning (Harackiewicz, Smith & Priniski, 2016). By applying interest theory in education, intrinsic motivation for learning can be nurtured (Hidi & Harackiewicz, 2000; Renninger, Sansone, & Smith, 2004).

Therefore**, this investigation focused on the reading literacy of Hong Kong junior secondary school students in STEM. It aimed to investigate the effectiveness of exploring STEM through literature in Hong Kong local secondary school setting.**

1.2. Research Objectives

This research studies the factors that impact junior form students to read STEM literature, the performance of integration and interpretation, how reading literature contributes to junior form students' learning in STEM and the changes of attitude towards STEM after reading STEM literature. Besides this, it discusses what we can do to create a better learning environment in the future. It analyzed Hong Kong's recent development in enhancing the effectiveness of exploring STEM through literature.

The purpose of this research is that provide insights to schools and teachers in discovering the ways to improve students' effectiveness in exploring STEM through literature. It wished to develop a more effective learning environment to reach the goal of reading to learn and hence encourage life-long learning. The education reform starts from the classroom.

1.3. Research Questions

There are four main questions for this research.

(1) What factors affect junior form students in reading STEM literature?
(2) How well do junior form students integrate and interpret reading STEM literature?
(3) Does literature reading assist junior form students in learning STEM disciplines?
(4) Do junior form students have a positive attitude towards STEM after reading STEM literature?

2. Section 2: Literature Review

2.1. STEM Education

The term "STEM" stands for Science, Technology, Engineering and Mathematics. Its origins in the 1990s at the National Science Foundation (Bybee, 2013). It fosters interdisciplinary learning. Science emphasizes the application of scientific methods; technology focuses on the identification, problem addressing and evaluation of existing technology; engineering features the determination and design of a new product; and mathematics sharpens the application of instruments for

measuring, analyzing and reasoning mathematically (Bybee, 2013). STEM education has eight characteristics. They are cross-disciplines, experiential learning, authentic learning, skills acquisition, empirical, designability, collaboration and interestingness (香港青年協會，2017).

Also, there are many advantages of promoting STEM education. It follows the global trend as it prepares students to cope with future challenges in the 21st century. **Students can acquire various skills through STEM education, including problem-solving, creative thinking, critical analysis, collaboration, independent thinking, initiative, communication, and digital literacy. (Government of Western Australia Department of Education, n.d.).** The final goal is to equip the next generation with STEM-related knowledge and skills to deal with the fast-changing world, which in turn, they can contribute to STEM-related fields to maintain national competence. That is the reason why nurturing students with STEM literacy is essential.

Therefore, promoting STEM education is an economic factor in developing and developed countries (Kennedy & Odell, 2014).

2.2. STEM Education in Hong Kong

Education Bureau of Government of HKSAR (2016) pointed out that STEM education in Hong Kong concentrates on the key learning areas of Science, Technology and Mathematics Education. It also emphasised that schools should implement suitable strategies to promote continuing development in Science, Technology and Mathematics Education.

Consequently, the Hong Kong Government has been putting a great effort to develop innovation and technology. Also, social discussion on STEM-related fields' development of innovation has been increasing dramatically. They come together to create a favourable atmosphere for the development of STEM education. The Panel of Education has concerned STEM education development in the Hong Kong local school context several times since 2015. It was eventually first announced in the 2015 Policy Address, followed by further assistance in the 2016 and 2017 Policy Address (2015 Policy Address, 2015; 2016 Policy Address, 2016 & 2017 Policy Address, 2017). At the end of 2016, the Education Bureau of Government of HKSAR issued the "Report on Promotion of STEM education – Unleashing Potential in Innovation". To boost the school-based STEM education curriculum development, the government supplied HK$200,000 to each secondary school (Tang, 2017).

To further clarify, the Education Bureau of the HKSAR government proposed five guiding principles for STEM education promotion[2] in Hong Kong local school context. It prepares the younger generation with the ability to face accelerated reformations and unpredictable challenges in the 21st century (Education Bureau of Government of HKSAR, 2016). **The corresponding objectives are providing a knowledge base among students, enhancing their interest in STEM disciplines, cultivating their ability to integrate and apply knowledge and skills, developing the skills of creative thinking, collaboration and problem-solving (Education Bureau of Government of HKSAR, 2016).** The goal is to equip lifelong learners of science and technology and the all-rounded development of students. And hence, they facilitate the forthcoming development of Hong Kong.

2.3. Reading to Learn

The Curriculum Development Council Report, "Learning to Learn – The Way Forward in Curriculum Development" stated that Four Key Tasks[3] aim to facilitate students' development of independent learning abilities within and across the 8 Key Learning Areas[4] (as cited in Curriculum Development Council, 2002). Reading to Learn is one of the Four Key Tasks. Making a good reading environment in schools is essential. **Students can develop their interest in reading** (Curriculum Development Council, 2002). There are five objectives of Reading to Learn. They are to improve **proficiency in the languages of students**; **develop their thinking skills through literature reading**; **achieve a quality of life through reading**; **cultivate an open mind**; and **enrich their knowledge base to widen their understanding of life** (Curriculum Development Council, 2002).

Besides this, there are some proposed outcomes of "Reading to Learn". Students should be supposed to transform from "Beginners" to "Proficient Readers" (Curriculum Development Council, 2002). They are **willing to read literature and can read without any guidance**. Thus, **reading becomes a regular activity. The ultimate goal is to enhance life-long learning**.

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[2] The five guiding principles:
I. Adopting a student-centered approach;
II. Enhancing STEM-related learning opportunities, including learning opportunities outside traditional classroom learning;
III. Maintaining a balance between students' interests and needs, teachers' opinions as well as views of other stakeholders;
IV. Establishing the strengths of past experiences and conductive factors of the schools in promoting STEM education;
V. Considering the promotion of STEM education as an ongoing improvement process
(Education Bureau of Government of HKSAR, 2016).

[3] They are Moral and Civic Education, Reading to Learn, Project Learning and Information Technology for Interactive Learning.

[4] They are Chinese Language Education, English Language Education, Mathematics Education, Science Education, Technology Education, Personal, Social & Humanities Education, Arts Education and Physical Education.

To achieve the noted outcomes and objectives, schools should encourage students to read beyond the boundary of "curriculum prescriptions" (Curriculum Development Council, 2002). Reading Across the Curriculum" should be promoted, instead of limiting reading to one discipline. It can **equip students with the capability to link different learning experiences** (Curriculum Development Council, 2017). STEM is an illustration of an integrated curriculum. Schools should utilize multi-dimensional resources to foster intellectual curiosity (Curriculum Development Council, 2002). It is suggested to set up a "STEM corner" to introduce STEM-related literature (Curriculum Development Council, 2017). To further enhance reading experiences, it is good to utilize various e-resources linked to STEM[5] (Education Bureau of Government of HKSAR, 2016).

2.4. Reading Literacy

Reading literacy is the ability to understand, apply, reflect and engage with written texts, to achieve one's goals, develop one's knowledge and potential, and participate in society (OECD, 2019). Readers can learn from various text types[6] to acquire knowledge. When they are reading, they must bear a critical mind to address numerous purposes (Mullis & Martin (Eds.), 2019). Readers actively construct meaning, reason with the text, know effective reading strategies and reflect on reading (Mullis, & Martin (Eds.), 2019).

Nowadays, digital technologies create a revolution in the written word. Digital reading is becoming a key component of school curricula and one of the popular ways students acquire information. It is essential for students to learn how to draw on and make effective use of the e-resources[7] to enhance their understanding of texts and enjoyment of reading (Curriculum Development Council, 2017). As a result, new digital reading literacies are necessary for reading on the internet. By mastering reading literacy, people can meet reading goals by efficiently finding and comprehending the target information. The first step is to access and retrieve information (陳木金和許瑋珊，2012). Digital readers must be selective in what they read to construct their texts by selecting and assessing relevant information from various (OECD, 2021). Readers must access the appropriate website, and then use navigation strategies (e.g., multiple navigation and sub-navigation menus, tabs, and links) to find the target information efficiently ("A Definition of Reading Literacy – Assessment Frameworks"). The second step is to **integrate and interpret information** (陳木金和許瑋珊，2012). Reading for informational purposes on the internet requires all the reading comprehension skills and strategies necessary for reading traditional

[5] For example, e-library, online courses, e-textbooks, and other resources related to STEM education.
[6] For example, traditional written forms, such as books, magazines, documents, and newspapers, as well as digital forms that include the numerous ways of communicating via the internet and websites.
[7] For example, sounds, images and videos

printed text (Mullis, & Martin (Eds.), 2019). **Readers can benefit from effective strategies that help them think about, monitor and adjust their readings for a particular goal** (OECD, 2021). **Readers can also construct a more specific and complete understanding of the text by integrating personal knowledge and experience with the meaning that resides within the text (Mullis, & Martin (Eds.), 2019).** The last step is doing reflection and evaluation on reading. It means that the readers have to make a reflection on the implicit messages to connect the context with daily life or personal experiences and evaluate the context critically based on prior knowledge or experiences (陳木金和許瑋珊，2012). Reading in a digital world requires examining the quality and validity of different sources, navigating through ambiguity and constructing knowledge continuously (OECD, 2021). Discussing what have read with different groups of individuals allows young students to gain an understanding and appreciation of the information (Mullis, & Martin (Eds.), 2019).

2.5. Attitude

Willingness to learn is a powerful attitude to make sure one's outstanding adaptation to the dynamically changing world (OCED, 2004). In other words, self-belief and self-management improve learning. **Inspiring and noteworthy reading activities can reinforce students' appreciation of the value of reading and make reading a lifelong habit** conclusively (Curriculum Development Council, 2017). Interest enhances the clearness, deepness and accuracy in learning and memorization (Paul, 2013). **The vital factor for motivating learning and achieving academic success is genuine interest** (OCED, 2004). **One of the ways to develop students' learning interests is through authentic assessment.** When they realise the task is closely correlated to daily life, they are more likely to take part in learning (Dempsey & Litchfield, 2015). It helps to develop intrinsic motivation. The knowledge base is co-constructed with the interaction between individuals and the environment (Dall'Alba & Vu, 2009).

However, **there is still room for improvement in Hong Kong students' motivation and engagement in reading** (Curriculum Development Council, 2017). Motivation is the driving force behind learning. **Interest in and enjoyment of a subject is a comparatively stable factor that influences the extent and continuity of learning engagement** (OCED, 2004). If people are interested in something, they are keen to pay additional effort. Thus, they gain knowledge more efficiently to intensify their critical thinking skills and deepen their understanding (Paul, 2013). For example, students with higher intrinsic motivation in learning Mathematics usually show more high-grade academic achievement than those with lower interest (OCED, 2004).
Therefore, **interest is a requisite factor for persisting and successful learning.** It should be under investigation when determining students' attitudes towards STEM.

3. Section 3: Methodology

3.1. Research Orientation

This research aimed to investigate the effectiveness of exploring STEM through literature in Hong Kong local secondary school setting. The research method used is mixed research. The purpose is to gain in-depth insight into the factors that affect junior form students in reading STEM literature, the ability to integrate and interpret and the contribution of promoting reading literature to junior form students' learning in STEM.

3.2. Research Method

Mixed research was applied in this research. All students who participated in this investigation were on a voluntary basis. The purpose of **conducting survey research** was to investigate the factors that affect junior form students in reading STEM literature and the contribution of promoting reading literature to junior form students' learning in STEM. On the other hand, the reason for **collecting artefacts, i.e., worksheets, as a data collection method in quantitative and qualitative research** was to analyze how well junior form students integrate and interpret reading STEM literature.

The convenience sampling method was applied in this investigation to collect enough data to analyze and draw a conclusive result. Since the participants were under 18-year-old, their parents and the schools were informed to sign a consent form. Besides this, they had every right to withdraw from the investigation at any time without negative consequences. Their participations were voluntary with a clear understanding of the research purpose and the data dealing.

3.3. Data Collection

For research question 1[8], 3[9] and 4[10], survey research was conducted with each individual participant to collect data. The aims of this questionnaire *(see appendix 5.1)* were to ask for the reasons for them to read STEM literature or not to read STEM literature, the effectiveness of learning STEM disciplines through literature reading and the attitude of junior form students towards learning STEM disciplines after reading STEM literature. The questionnaire was written in traditional Chinese which was the students' native language. In questionnaire, there were **serval closed-ended questions and semi-closed questions**. By asking semi-closed questions, participants could express their opinions freely. So that, it allowed the researcher to collect data from diverse perspectives.

[8] What factors affect junior form students in reading STEM literature?
[9] Does literature reading assist junior form students in learning STEM disciplines?
[10] Do junior form students have a positive attitude towards STEM after reading STEM literature?

For research question 2[11], it was decided to access students' integration and interpretation skills on literature reading by analysis their performances on the designed worksheet *(see Appendix 5.2)*. The content of the worksheets was about STEM. The topic was food nutrition. The worksheet was written in traditional Chinese which was the students' native language. Students had to do some literature readings, calculations and finally design a healthy food menu. The design of the worksheet is problem-based and authentic, which covers all elements in STEM, i.e., Science, Technology, Engineering, and Mathematics. The goal is to propose a solution of the problem. The participants had to figure out the answer from the provided literature. Also, they were required make use of the content in the literature into authentic situation, i.e., design a healthy menu. So that, the students' performance in integrating and interpreting the data of STEM literature reading could be accessed in all-rounded.

3.4. Data Analysis

First, to analyze the quantitative data, the researcher used descriptive analysis. The data collected are analyzed by calculating the percentage, mode, mean and standard deviation (SD). All the data are presented by charts or graphs based on the nature of the questions.

For research question 1[12], data was analyzed by finding the mode, the percentages in different factors.

For research question 2[13], data were analyzed by mean, minimum, maximum, median, upper quartile, lower quartile, standard deviation (SD) as well as passing percentage overall. If the mean is high, the junior form students perform well in integrating and interpreting reading STEM literature, vice versa. Besides this, the correct percentages on each question are analyzed. In addition, the answers of the participants *(see Appendix 5.2)* were analyzed in the qualitative analysis method. For example, how detailed or accurate the answers were and whether the answers were given based on the provided STEM literature.

For research 3[14], data were analyzed by calculating the mean and standard deviation (SD). Since the questions were rated using a four-point Likert item (extremely low = 1, low= 2, high = 3, and extremely high = 4), the researcher could conclude that there is a negative result when the mean conducted is lower than 3, vice versa. As the sample size of this research is small and the mean is

[11] How well do junior form students integrate and interpret reading STEM literature?
[12] What factors affect junior form students in reading STEM literature?
[13] How well do junior form students integrate and interpret reading STEM literature?
[14] Does literature reading assist junior form students in learning STEM disciplines?

sensitive to extreme values, SD are used to measure the central tendency. All data were rounded to 2 decimal places if necessary.

For research question 4[15], the change in time of reading STEM literature before and future estimation and the change in interest towards STEM literature were compared by percentage as well as mean. Since some questions were rated using a four-point Likert item (extremely low = 1, low= 2, high = 3, and extremely high = 4), the researcher could conclude that there is a negative result when the mean conducted is lower than 3, vice versa. As the sample size of this research is small and the mean is sensitive to extreme values, SD are calculated to measure the central tendency. All data were rounded to 2 decimal places if necessary.

3.5. Limitations of Research Design

There are three limitations in this investigation.

First, due to the choosing of the convenience sampling method, the participants only represent a specific group of junior form students. Nearly a third of the participants came from one secondary school. So, they may have similar experiences and similar views in some aspects of research questions. It affected the degree of representation of the result.

Second, in terms of the sample size, the point of view of 31 junior form students from different local secondary schools is only represented part of the fact of the effectiveness of exploring STEM through literature in Hong Kong local secondary school setting.

Third, there is only one marker who marked the worksheet. So, it may affect the accuracy in evaluating the performance of junior forms students' integration and interpretation skills in some extent.

[15] Do junior form students have a positive attitude towards STEM after reading STEM literature?

4. Section 4: Findings and Analysis

4.1. Factors affect junior form students in reading STEM literature

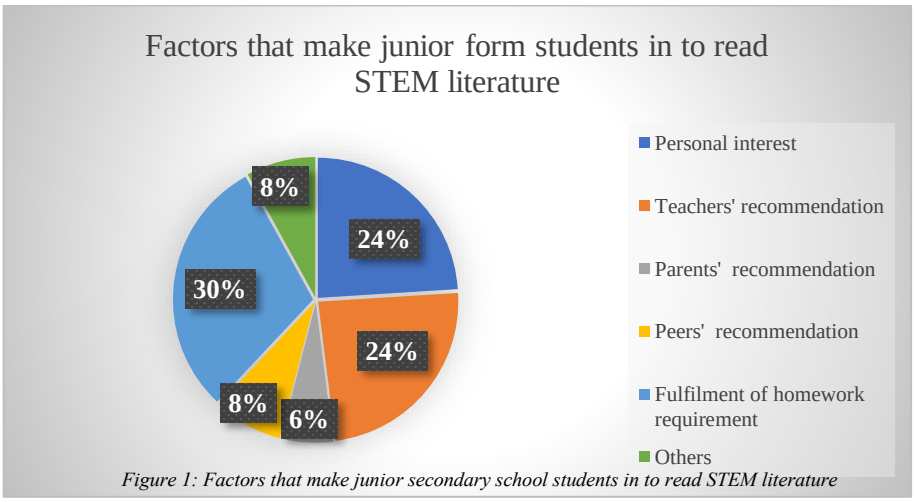


Figure 1: Factors that make junior secondary school students in to read STEM literature

According to figure 1, **"fulfilment of homework requirement" is the most affective factor that makes junior form students read STEM literature. It comprises nearly a third of the total response. While "personal interest" and "teachers' recommendation" are the second most popular reason, having almost a quarter of the total response respectively.** Both "peers' recommendation" and "Others" make up just under 10% of the total response accordingly, which are a third less than the most common factor, "fulfilment of homework requirement". "Parents' recommendation" is the least vital factor, accounting for 6% of the total response.

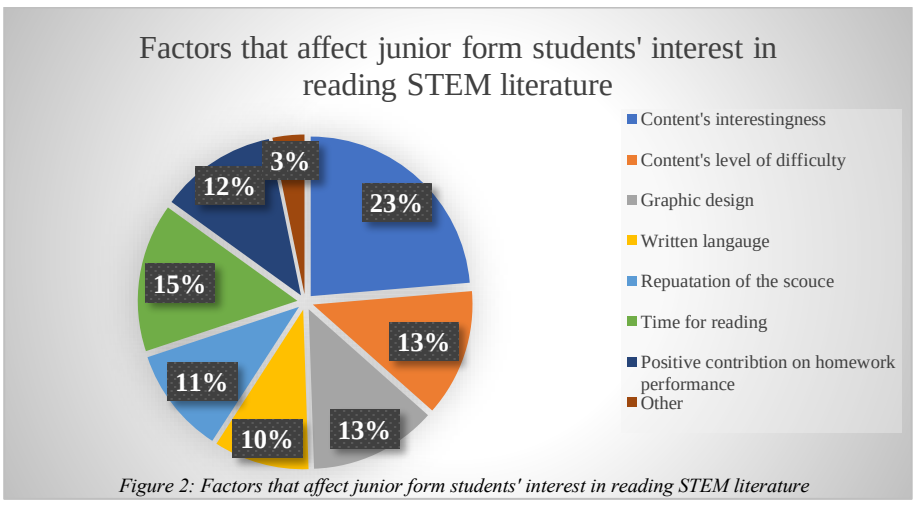


Figure 2: Factors that affect junior form students' interest in reading STEM literature

According to figure 2, **"content's interestingness" is the biggest concern of junior form students in choosing STEM literature, comprising nearly a quarter of the total response.** The degrees of affection brought by "time for reading", "content's level of difficulty", "graphic design", "positive contribution on homework performance", "reputation of the source" and "written language" are similar which are around 10% to 15% of the total response. In contrast, "other" is the least popular factor that affects junior form students' interest in reading STEM literature, making up only 3% of the total response.

4.2. Junior form students' performance in integrating and interpreting reading literature

Table 1

Junior form student's performance in integrating and interpreting reading literature (overall)

Mean	SD	Min	Q1	Median	Q3	Max	Passing rate	Passing mark	Full mark
6.39	3.18	0.00	4.00	6.00	9.00	12.00	61%	6	12

All the participants completed a worksheet about STEM. The total mark of this worksheet is 12, and the passing mark is 6 out of 12. According to table 1, **the passing rate is 61%**, which is just above half of them. **The mean is 6.39**, which is slightly higher than the passing mark. **The range is large.** The minimum score is 0 while the maximum score is 12. Besides this, the standard deviation is 3.18.

Table 2

Junior form students' performance in integrating and interpreting reading literature (per each question)

Part 1				
	Correct (%)		**Incorrect (%)**	
Q1	74%		26%	
Q2*	26%		74%	
	Correct (%) [3 marks]	**Correct (%) [2 marks]**	**Correct (%) [1 mark]**	**Incorrect (%) [0 mark]**
Q3*	12.903%	6.452%	35.484%	45.161%
Part 2				
	Correct (%)		**Incorrect (%)**	
Q1 *	90%		10%	
Q2	32%		68%	
Part 3				
	Correct (%)		**Incorrect (%)**	
Q1*	81%		19%	
Q2*	81%		19%	
Q3*	81%		19%	
Part 4				
	Correct (%)		**Incorrect (%)**	
Q1*	42%		58%	
Q2*	32%		68%	
* Short question				

By table 2, **for part 1, the correct parentage of Q1 is 74% while that of Q2 is 26%.** Q1 is a multiple-choice question while Q2 is a short question. Q3 is also a short question, which consists of 3 marks, 1 mark are given for 1 correct answer. **The percentages of participants who obtain 3 marks, 2 marks, 1 mark and 0 mark are 12.093%, 6.452%, 35.484% and 45.161% respectively.**

For part 2, the correct percentage of Q1 is 90%, which is very high. However, that of Q2 is low, having 32% only.

For part 3, Q1 to Q3 is asked the participants to design a tailor-made daily menu for a mentioned character. There is no model answer for these questions. When they wrote something relevant, they would obtain 1 mark per question. The correct percentages for these three questions are high, both having 81%. The remaining 19% obtain no mark because they did not write anything or wrote something extremely irrelevant, like having drinking water the whole day only.

For part 4, the correct percentages for both Q1 and Q2 are low, having 32% and 42% respectively.

Next, the performance on short questions will be also analyzed qualitatively *(see table 3)*. There are several short questions in the worksheet *(see table 2).*

Table 3

Qualitative analysis on short questions of the worksheet

	Performance	Description
Part 1		
Q2	Poor	**Most students gave their answers based on pervious knowledge or common sense, rather than answering based on the information provided on the given STEM literature.** For example, "Ting Ting's BMI is high". However, the given STEM literature did not mention about BMI. Moreover, BMI calculation is not applicable to Ting Ting's situation since BMI calculation is suitable for adult, but she is a teenager. Therefore, they did not obtain any mark. Besides this, **students failed to interpret the answer in a correct way. They found the relevant source from the provided STEM literature and just direct copied the words. They did not do any interpretation.** For example, one of the students wrote "according to the providing STEM literature, the median of a 15-year-old girl's median weight should be 41.kg." That student did not make comparison between the standard median weight and Ting Ting's weight.
Q3	Poor	**Most students gave their answers based on general understanding, rather than answering based on the information provided on the given STEM literature.** For example, they wrote Ting Ting are

		overweight because of "eating too much junk food", "having less vegetables", "love to eat French fries, ice-cream and soft drink" and "consuming excess nutrients". All these answers are not mentioned in the reading literature.
Part 2		
Q1	Good	**Most students performed well in this question. They could find the correct answer from the given table.**
Part 3		
Q1	Good	**Most students performed well in this question.** There is no model answer for this question. They just had to design a breakfast for Ting Ting. **Some students performed below standard just because they refused to write anything.**
Q2	Good	**Most students performed well in this question.** There is no model answer for this question. They just had to design a lunch for Ting Ting. **Some students perform below standard just because they refused to write anything.**
Q3	Good	**Most students performed well in this question.** There is no model answer for this question. They just had to design a dinner for Ting Ting. **Some students performed below standard just because they refused to write anything.**
Part 4		
Q1	Poor	Most student performed poorly in this question. Some of them calculated the answer wrongly because they could not find the correct data from the provided information. There were also some of them gave up answering this question. On the other hand, there was one common characteristics of high achievers. They could usually integrate and interpret the information in detail. They sorted the useful information from the provided STEM literature and listed out all energy values of food. They, then, calculated the total energy value of their own designed menu. For example,

		1] 2片白麪包(500)、1隻烚雞蛋(142)、1個蘋果(52)、1杯240ml低脂奶(42)=736千卡 2] 1隻炒蛋(212)、1 一碟炒大白菜(16)、半份(1/2碗)切粒芒果(65)、1份意粉(151)=444千卡 3] 1.5碗飯(195)、1 一碟炒椰菜(25)、1隻烚雞蛋(142)、1磚豆腐(76)、4-5塊烚雞胸肉(252)、1個梨子(58)=748千卡 4] 總共1928千卡
Q2	Poor	Most students failed to make use of the provided information on the STEM literature to integrate and interpret the answer. There are a few of them did not answer this question.

To conclude, **junior form students' ability in integrating and interpreting reading literature is satisfactory but diverse.** The average performance of junior form students is satisfactory since the mean of the overall mark is just slightly above the passing mark, which is 6.39 out of 12 *(see table 1)*. The range and standard deviation are large, which are 12marks and 3.18 respectively *(see table 1)*. **The students performed well in the questions that required fundamental integration and interpretation skills.** The correct percentages of Q1 in part 1 and Q1 in part 2, which required students to find the answer directly from the provided STEM literature, are high *(see table 2)*. **However, the students performed poorly in the questions that required advanced integration and interpretation skills.** The correct percentages of Q2 and Q3 in part 1, Q1 and Q2 in part 4 are less than half *(see table 2).*

4.3. Contribution of literature reading in assisting junior form students' learning in STEM disciplines

Table 4

Contribution of literature reading in assisting junior form students' learning in STEM disciplines (students' perspective)

Question	Mean	SD
How much do you think reading STEM literature can help you in learning STEM-related subjects?	2.93	0.66

From table 4, the mean of junior form students' opinion on contribution of literature reading in assisting junior form students' learning in STEM disciplines is 2.93, which is slightly less than 3. **It shows that junior form students' point of view towards the contribution of literature reading in assisting their learning in STEM disciplines is somewhat negative.**

4.4. The changes of attitude towards STEM after reading STEM literature

Table 5

The changes of attitude towards STEM after reading STEM literature

Question	Mean	SD
How much did you interested in STEM literature before?	2.55	0.87
How much do you willing to read STEM literature in the future?	2.77	0.76

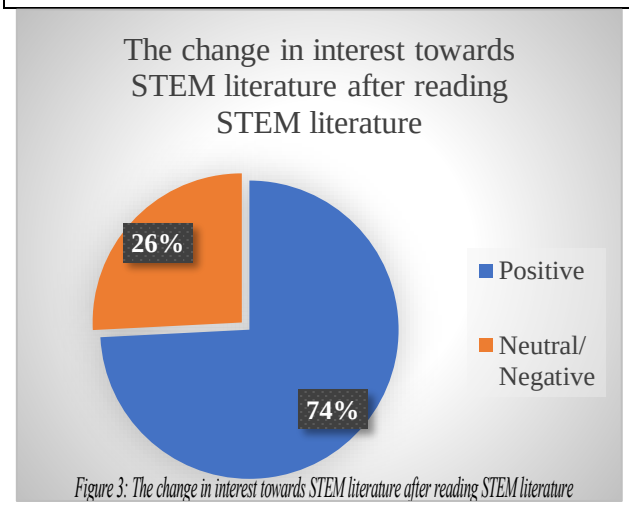


Figure 3: The change in interest towards STEM literature after reading STEM literature

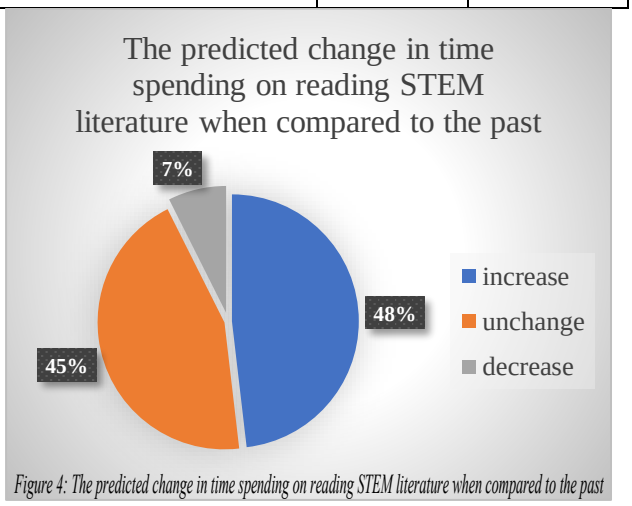


Figure 4: The predicted change in time spending on reading STEM literature when compared to the past

First, **looking at the junior form students' interest in STEM literature before, according to table 5, the mean is 2.55. The value is under 3, which indicates general junior form students are not interested in STEM literature previously.**

Next, consider the changes in junior form students' interest in STEM literature after having exposure to STEM literature. According to figure 3, almost three-quarters of the participants (junior form students) become more interested in STEM literature, while 26% did not become more interested in STEM literature or less interested in STEM literature. **It shows that junior form students' interest in STEM literature after reading STEM literature is generally increasing.**

In addition, according to figure 4, 48% of the junior form students are willing to spend more on reading STEM literature in the future, and 52% of them will spend the same or even less time on reading STEM literature in the future. Also, according to table 2, the mean of junior form students' who are willing to read STEM literature in the future is below 3, having 2.77. **It demonstrated that junior form students are not determined to read more STEM literature.**

In conclusion, despite having a positive change in the interest in STEM literature, junior form students will not read more in the future.

5. Section 5: Discussion

5.1. Factors affect junior form students in reading STEM literature

To begin with, in this investigation, **the fulfilment of homework requirements and teachers' recommendations are the most decisive factors, which consider extrinsic motivation.** Extrinsic motivation is influenced by various social-environmental elements, such as reward, expected evaluation and time limits (as cited in Altringer, Amabile, Hennessey & Moran, 2015). First, most junior form students are motivated to read STEM literature to attain the objectives and constraints imposed by teachers. They consider reading STEM literature as a task. **Homework is an incentive to let junior form students read STEM literature**. Second, teachers play a crucial role in students' reading of STEM literature. 24% of the total response reveals that junior form students read STEM literature because of teachers' recommendations, which outraces the impact of parents' and peers' recommendations *(see figure 1)*. One of the possible reasons is that students spend more additional time at school (as cited in Chiang & Liu, 2019, p.4). **It shows that teachers play an influential role in junior form students' reading habits on STEM literature. The interaction between students and teachers are correlated to students' learning motivation significantly, especially in Chinese society (Chiang & Liu, 2019).** It is believed that enthusiastic teachers help instil in students positive subjected-related activities and positively impact students' motivation and interest (Becker, Goetz, Hensley, Keller, & Morger, 2014).

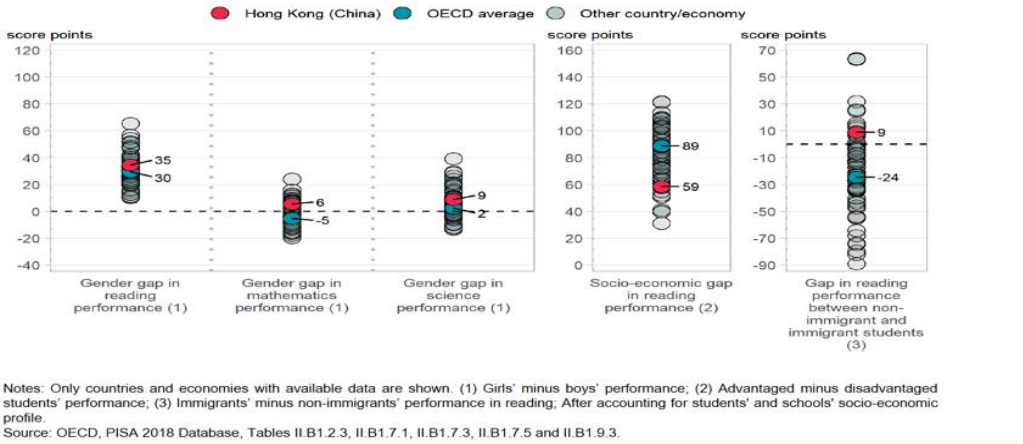
Furthermore, **being one of the second significant factors, "personal interest" makes a vital impact on junior form students' reading habits.** It accounts for 24% of the total response. It is considered an intrinsic motivation, which is a relatively stable and permanent impact (Hoose, n.d.). People who are motivated intrinsically are influenced by some internalized elements such as joy (Altringer, Amabile, Hennessey & Moran, 2015). In other words, **junior form students want to read STEM literature because they can gain pleasure from reading.** According to figure 2, **"content's interestingness" is the most influential determinant of junior form students in choosing STEM literature.** It initiates the personal interest of junior form students in STEM literature.

To conclude, **extrinsic and intrinsic factors contribute to the junior form students' reading habits in STEM literature.** Doing the homework to comply with requirements and advice-seeking from teachers for new materials may coexist with the personal interest (Lemos & Veríssimo, 2014).

5.2. Junior form students' performance in integrating and interpreting reading STEM literature

In most education systems, reading instruction may be implicitly or incidentally delivered in language lessons, instead of teaching in a systematic practice (OECD, 2019). **Hong Kong students acquire reading skills through Chinese or English lessons implicitly. They do not receive formal training in reading strategies.**

In addition, the gaps in students' performances in reading, mathematics and science are huge. According to OECD (2019), **in terms of gender, the disparities in reading performance, mathematics performance and science performance of Hong Kong students are slightly larger than the OECD average,** while **the difference in reading performance between non-immigrant and immigrant students** is **significantly larger than the OECD average by 33 score points** *(see figure5)*. New arrivals from other places encounter enormous challenges. For example, adapting to different academic expectations and a new language (Schleicher, 2018).



Notes: Only countries and economies with available data are shown. (1) Girls' minus boys' performance; (2) Advantaged minus disadvantaged students' performance; (3) Immigrants' minus non-immigrants' performance in reading; After accounting for students' and schools' socio-economic profile.
Source: OECD, PISA 2018 Database, Tables II.B1.2.3, II.B1.7.1, II.B1.7.3, II.B1.7.5 and II.B1.9.3.

Figure 5: Differences in performance related to personal characteristics

According to this investigation, the junior form students' performance in integrating and interpreting reading literature is satisfactory as the mean of the overall performance is 6.39 marks, which is above the passing line (see section 4.2). However, **the performance level is diverse.** According to figure 1, the range and SD are large (see section 4.2). The diverse performance level among junior form students' integration and interpretation in reading STEM literature under this investigation reveals that **there is a gap among them**.

Moreover, **when comparing the performance in questions with different levels of complexity, the diversity among junior form students' performance in integrating and interpreting reading STEM literature becomes remarkable.** It reveals two things.

Firstly, it shows that the low achievers do not acquire advanced integration and interpretation skills. The overall performance in questions that required a fundamental level of integration and interpretation skills is good, while those that required an advanced level of integration and interpretation skills are poor *(see section 4.2)*. The high achievers usually performed well in most questions, while the low achievers only demonstrated the elementary level of integration and interpretation skills.

Secondly, it shows that the high achievers have a higher intrinsic motivation to read and demonstrate the ability to read without any guidance. As it is not compulsory to finish all questions on the worksheet, students decided to answer all questions or not freely by themselves. The performance result in the worksheet shows that **there is diversity in the degree of intrinsic motivation among junior form students.** The high achievers answered all questions, while the low achievers gave up on answering advanced questions. **Motivation is a prognostication of self-fulfilling as high-motivated students are more willing to invest efforts (Mo, 2019). So, this brings positive results in performance (Akbar, Buzdar, Mohammad & Mohsin, 2017).** In contrast, low motivation may lead to poor performance. Meanwhile, poor performance may create frustration and a sense of helplessness (Mo, 2019). Therefore, as intrinsically motivated students are willing to take on challenges and work with interest, there is a substantial impact of performance on students' intrinsic motivation

5.3. The effectiveness of exploring STEM through literature in Hong Kong local secondary school setting

There are two criteria to evaluate the effectiveness of exploring STEM through literature in Hong Kong local secondary setting. They are **the change in students' interests** and **the predicted change in reading times**.

5.3.1. In terms of developing junior students' interest in reading STEM literature

To begin with, **in terms of developing junior students' interest in reading STEM literature, it is effective.** The result shows that the mean of junior form students' previous interest in STEM literature is below 3 *(see table 2)*, which indicates junior form students are not very interested in reading STEM literature before. In contrast, there is an upward trend after they explored STEM literature. According to figure 3, nearly 75% of the junior form students claimed that they became more interested in STEM literature after having exposure to STEM literature *(see figure 3)*.

In this investigation, the participants have to read through some pieces of online STEM literature. Then, they have to apply the information obtained to solve an authentic problem *(see section 3.3 &*

appendix 8.2). It shows that when students find reading is meaningful and useful, they develop a positive attitude toward reading. **By applying information obtained from STEM literature to solve an authentic problem in this investigation, junior form students can gain a sense of achievement and find reading STEM literature is worthful. Referring to section 2.5, when students can see the relationship between their work and daily life, they are more eager to learn. It helps to develop students' interests.**

To sum up, exploring STEM through literature in Hong Kong local secondary setting is somewhat effective in triggering junior form students' interest in STEM. It also shows that reading interest can be developed.

5.3.2. In terms of increasing junior students' reading times

There is still room for improvement in increasing junior form students' reading times. The willingness of junior form students in reading STEM literature in the future is 2.77 *(see table 5)*, which indicates **junior form students will not read more STEM literature in the future.** Meanwhile, **over half the percentage of junior form students reported that their reading times in the future will remain the same as before or even less than before *(see figure 4)*.** It may be due to several reasons.

First, one of the possible reasons is that **junior form students do not think reading STEM literature can assist them in learning STEM disciplines in school.** Referring to table 4, the mean of junior form students' opinion on the contribution of literature reading in assisting junior form students' learning in STEM disciplines is 2.93, which is slightly less than 3. In PISA 2018, over a quarter of students agreed or strongly agreed that reading wastes their time (OECD, 2021). As students think reading STEM literature is useless, they do not have enough intention to read in their spare time.

Second, another possible reason is **reading is stressful for junior form students** (趙文浩，2020). **Schools tend to "quantify" the reading habits of students.** For example, making "increase book loan volume by 10%" be a year goal. **According to this investigation, the most common factor that makes junior form students read STEM literature is the fulfilment of homework requirements, comprising 30% of the total response *(see figure 1)***. It makes reading becomes a kind of homework. Students read because they are forced to read by their teachers. Once they are not required to read STEM literature, they will not read them.

Third, the last possible reason is **that some students do not have adequate skills to integrate and interpret information on STEM literature.** In this investigation, the performance of junior students in integrating and interpreting STEM literature is diverse *(see section 4.2)*. **Students with more difficulties reading and who are self-recognized as less skilled readers are less motivated to read for enjoyment (OECD, 2021). Reading engagement and performance is interrelated (Nurmi et al., 2003).**

Therefore, there is still room for improvement in enhancing the effectiveness of exploring STEM through literature in Hong Kong local secondary school setting, especially in increasing students' reading time.

5.4. Suggestions to improve the effectiveness of exploring STEM through literature in Hong Kong local secondary school setting developing

From 5.3, there is still room for improvement in enhancing the effectiveness of exploring STEM through literature in Hong Kong local secondary school setting development. So, it is going to propose some suggestions to improve the situation.

5.4.1. Transforming extrinsic motivation into intrinsic motivation through authentic tasks

First, transforming extrinsic motivation into intrinsic motivation. In other words, **making personal interest to be the most significant factor that forces them to read STEM literature**. Reading for homework makes reading activity becomes a stressful task (趙文浩，2020). Personal interest is intrinsic motivation. It is associated with positive feelings and linked to anxiety negatively (as cited in Fortus & Vedder-Weiss, 2012, p.1066). According to the Curriculum Development Council (2017), "making connections" enables students to construct links between their prior knowledge and new learning while reading. **Applying information obtained from STEM literature to solve an authentic problem in this investigation, students develop their interest in reading STEM literature (see sections 4.3 & 5.3.1). It helps students to develop problem-solving skills and enrich their knowledge base to widen their understanding of life.**

Therefore, it is believed that if teachers can further **strengthen the authenticity of teaching tasks**, students can be more able to recognize the links between STEM literature and real life. **For example, making students themselves or people around them, like classmates, be the main character of the case that they are going to study.** To fit in this investigation, let students identify the healthy status of themselves or their friends, and then, tailor-make a healthy menu for that particular "real" person, instead of for an imaginary person, "Ting Ting". **When students see**

the value in an assignment, they are more willing to spend time and energy on it (Dempsey & Litchfield, 2015). Time on a task usually leads to increased competence. So, by integrating personal knowledge and experiences with the meaning that resides within the text, students can develop a more concrete and comprehensive understanding of the text (Mullis, & Martin (Eds.), 2019).

To conclude, when junior form students read because they are interested in reading, they consider reading as a kind of enjoyment. Reading STEM literature becomes part of their identity and sense of self. A student commits more to the activity and for a longer time if he/ she is interested in and enjoys it (as cited in Hoose, n.d.). The enjoyment of a subject is a relatively stable factor that impacts the degree and continuity of learning engagement (OCED, 2004). **Eventually, reading becomes a constant activity in life reading becomes a persistent daily activity and enhances life-long learning. Interest is a requisite factor for persisting and successful education.**

5.4.2. Teach junior form students reading strategies → Narrower gap

The learning and teaching method in Hong Kong is highly exam-oriented, which is in a different direction from the PISA assessment's focus and the trend of global education development. Teachers' teaching focus on training examination skills, instead of problem-solving skills *(refer to section 1)*. **Students lack experience in applying their knowledge in an authentic scenario.** Also, **Hong Kong students acquire reading skills through Chinese or English lessons implicitly, instead of through formal reading lessons directly.** In this investigation, the performance of junior form students' integration and interpretation skills in reading STEM literature is diverse *(see section 4.2)*. **There is a gap between the low achievers and high achievers.** So, it is crucial to narrower the gap.

To narrower the gap, teachers should equip students with enough reading skills. Reading ability and metacognitive strategies are correlated positively (as cited in OECD, 2019). **STEM literature usually contains technical terms and concepts. Teachers should teach them relevant prior knowledge, like technical terminologies, and serval reading strategies (Curriculum Development Council, 2017).** For example, in science, students can guide to develop the skill to read with the aid of diagrams, annotation and organizing the vocabulary learnt (Curriculum Development Council, 2017). By acquiring reading strategies, junior form students can accomplish reading comprehension effectively. **Direct teaching of reading strategies improves students' reading proficiency and reduces the gap among students (as cited in OECD, 2019).**

Furthermore, in this investigation, it is discovered that students with low ability in integrating and interpreting information cannot figure out the relationship between the provided STEM literature and the authentic situation. The low achievers in this investigation can find the related information from the given STEM literature, i.e., the daily energy value requirement of a 15-year-old girl. However, they fail to justify their menu by using the information found before. It shows that they cannot apply acquired knowledge in problem-solving. **It is suggested to use more questions to scaffold students to figure out the relationship. Besides, teachers can add more subtitles to the literature. So, students can be more able to figure out the relevant content by the clue given by teachers. Once they can see the connection, they know the meaning of reading STEM literature and find it worthful to read.** They can read and solve daily life problems by themselves finally. The goal of "reading to learn" is to acquire thinking skills through literature reading, achieve a quality of life through reading, cultivate an open mind, and enrich their knowledge base to broaden their understanding of life.

5.4.3. Improve students' view towards STEM

According to the investigation result, the most common factor is that junior form students read STEM literature because they want to meet the homework requirement. However, they do not think reading STEM literature is beneficial for learning STEM-related subjects *(see figure 1 & table 4)*. It implies that most junior form students read STEM literature passively. Therefore**, it is crucial to nurture students as active readers**.

To achieve this objective, teachers can **design some attractive and engaging reading activities which are related to subject contents that have been taught recently and are authentic.** There are three key sources of intrinsic motivation. They are challenge, curiosity and control (Lepper et al., 1997). According to this investigation, after having experience in applying information acquired in STEM literature to solve an authentic problem, students develop an interest in reading STEM literature *(see section 4.4)*. It helps to make a strong connection between reading to students' experiences.

Therefore, it is suggested to enforce the connection between reading and students' experiences. There are serval ways to make a connection. Apart from linking up with students' personal experiences *(see section 5.4.1)*, the connection can be created through school learning and global issues. They enable students to consolidate their subject knowledge, widen their horizons and stimulate their thinking (Curriculum Development Council, 2017). Adopting authentic task learning help students to gain a sense of achievement as they see their work can apply to solve the problem. To strengthen the sense of achievement, it is suggested to provide literature about a

successful case in real life for students to study before the problem-solving task. Take this investigation as an example, to highlight the sense of achievement, it is suggested to provide students with an article about a successful case that makes a patient becomes healthier after seeking advice from a nutritionist. So, students understand that they are taking a role as a nutritionist in this task and recognize that their plan can bring a positive effect on themselves and others. As a result, **students can develop a positive point of view towards the contribution of literature reading in assisting their learning in STEM disciplines.**

5.4.4. Teachers make recommendations to students based on their interests → Students discover their favourite reading content by themselves

Teachers influence students' motivation through instructional practices, encouragement and acting as role models. Students manage to adopt goals that are accentuated by teachers (as cited in Fortus & Touitou, 2021, p. 14). Both explicit and implicit messages delivered by teachers affect students' learning of science profoundly (as cited in Fortus & Touitou, 2021, p.12). According to this investigation, teachers' recommendation is one of the top two factors that for junior form students to read STEM literature *(see figure 1),* while "content's interestingness" is the biggest concern of junior form students in choosing STEM literature *(see figure 2)*. Based on these two findings, **teachers should recommend interesting STEM literature to junior form students based on their cognitive development and interest.** To cater for learning diversity in gender, background and motivation, **teachers should suggest a wide array of reading materials based on an individual's interests and learning progress** (Curriculum Development Council, 2017). For example, books, magazines, videos and social media accounts, etc. Also, **teachers can provide a book list of recommendations for each teaching topic to support students' further exploration of STEM literature.** With more recommendations, students know more about STEM literature. So, they can pack up the one they are interested in reading. Students usually enjoy classwork when they can choose for themselves (Foruts & Vedder-Weiss, 2012). **The research proposed that students who are allowed and encouraged to choose to read literature autonomously are more willing to pay effort into learning** (陳一銘和王文吟引，2018).

Therefore, to nurture active and independent readers, teachers should first guide students to find a reading material that they are interested in.

6. Section 6: Conclusion

From what have been discussed above, it could be concluded that:

(1) What factors affect junior form students in reading STEM literature?

The significant factors that make junior form students read STEM literature are “fulfilment of homework requirement”. Homework is an incentive to let them read STEM literature. It is extrinsic motivation. “Personal interest” and “teachers’ recommendation” are the second most popular reason. The former is intrinsic motivation. Students read STEM literature because they can gain pleasure from reading. The latter is extrinsic motivation. Teachers have a great influence on students, especially in the Chinese community. While “interestingness of content” is the most crucial element that affects their choices in reading.

Therefore, to improve junior form students’ interest in reading STEM literature, it is suggested teachers can make recommendations to students based on their interests. For example, providing a further reading recommendation list with a wide array of books, articles, leaflets, magazines, websites and videos for each teaching topic. So, students can explore more STEM literature according to their interests.

(2) How well do junior form students integrate and interpret reading STEM literature?

The performance of junior form students in integrating and interpreting STEM literature is satisfactory in general but is various categorically speaking. The average mark of the performance is beyond average, but the range and SD are large. There is a large disparity between high achievers and low achievers due to serval reasons such as the gender gap, inequality between non-immigrant and immigrant students and intrinsic motivation.

To narrower the gaps, teachers should teach junior form students some reading strategies starting from form 1. For example, using more guiding questions and adding more subtitles to scaffold junior form students to comprehend the main messages of the STEM literature. And thus, they can figure out the connection between the provided STEM literature and the authentic situation. They can apply the knowledge to solve authentic problems.

(3) Does literature reading assist junior form students in learning STEM disciplines?

From junior form students' viewpoint, the assistance of literature reading in assisting their learning in STEM disciplines is moderately negative. They do not think reading more STEM literature can benefit academic performance.

However, their interest in reading STEM literature increases after having experience in applying information acquired in STEM literature to solve an authentic problem in this investigation. So, it is suggested that to improve students' view towards STEM by designing some attractive and engaging reading activities. The activities should be related to the subject contents and authentic. It helps students to make a connection between reading to students learning experiences and gives students a sense of achievement as they see their work can apply to solve a problem.

(4) Do junior form students have a positive attitude towards STEM after reading STEM literature?

In terms of developing junior students' interest, it is effective. It indicates that junior form students can gain interest in reading STEM literature through authentic tasks. When students realize the relationship between their work and daily life, they are more eager to learn.

However, in terms of reading times, it is unsatisfactory. Although junior form students have developed their reading interest in STEM literature, their willingness in reading STEM literature in the future is still low. It may be due to serval causes. For example, junior form students do not think reading STEM literature can assist them in learning STEM disciplines in school, reading is stressful for junior form students, and some students do not have sufficient skillsets to integrate and interpret information on STEM literature. Some solutions are proposed and discussed in section 5.4 to improve the situation.

7. Section 7: List of References

2015 policy address. (2015, January 14). Retrieved April 08, 2021, from https://www.policyaddress.gov.hk/2015/eng/p150.html

2016 policy address. (2016, January 13). Retrieved April 08, 2021, from https://www.policyaddress.gov.hk/2016/eng/p87.html

2017 policy address. (2017, January 18). Retrieved April 08, 2021, from https://www.policyaddress.gov.hk/jan2017/eng/p210.html

Akbar, R., Buzdar, M. A., Mohammad, N., & Mohsin, M. N. (2017). Students' Academic Performance and its Relationship with their Intrinsic and Extrinsic Motivation. *Journal of Educational Research (1027-9776), 20*(1).

Altringer, B., Amabile, T. M., Hennessey, B. & Moran, S., (2015). Extrinsic and intrinsic motivation. *Wiley encyclopedia of management*, 1-4.

Becker, E. S., Goetz, T., Hensley, L., Keller, M. M., & Morger, V., (2014). Feeling and showing: A new conceptualization of dispositional teacher enthusiasm and its relation to students' interest. *Learning and Instruction*, *33*, 29-38

Bybee, R. W. (2013). *The case for STEM education: Challenges and opportunities*. NSTA press.

Chiang, Y. L., & Liu, R. (2019). Who is more motivated to learn? The roles of family background and teacher-student interaction in motivating student learning. *The Journal of Chinese Sociology*, *6*(1), 1-17

Communication and Public Relation Office, The Chinese University of Hong Kong. (2019, December 3). CUHK releases the results of the programme for international Student assessment 2018: CUHK communications and public Relations Office. Retrieved April 08, 2021, from https://www.cpr.cuhk.edu.hk/en/press/cuhk-releases-the-results-of-the-programme-for-international-student-assessment-2018/

Curriculum Development Council. (2002). 3B: Reading to Learn. Basic Education Curriculum Guide: Building on Strengths (Primary 1 - Secondary 3). Hong Kong: Curriculum Development Council. Retrieved April 8, 2021, from https://cd1.edb.hkedcity.net/cd/EN/Content_2909/html/index.html

Curriculum Development Council. (2002). 4: Effective Learning and Teaching – Acting to Achieve. Basic Education Curriculum Guide: Building on Strengths (Primary 1 - Secondary 3). Hong Kong: Curriculum Development Council. Retrieved April 8, 2021, from https://cd1.edb.hkedcity.net/cd/EN/Content_2909/html/index.html

Curriculum Development Council. (2002). 7: Quality Learning and Teaching Resources and School Library Development – Bringing about Effective Learning. Basic Education Curriculum Guide: Building on Strengths (Primary 1 - Secondary 3). Hong Kong: Curriculum Development Council. Retrieved April 8, 2021, from https://cd1.edb.hkedcity.net/cd/EN/Content_2909/html/index.html

Curriculum Development Council. (2017). Booklet 6B: Reading to Learn: Towards Reading across the Curriculum. *Senior Secondary Curriculum Guide.* Hong Kong: Curriculum Development Council. Retrieved April 8, 2021, from https://www.edb.gov.hk/attachment/en/curriculum-development/renewal/Guides/SECG%20booklet%206B_en_20180831.pdf

Curriculum Development Council. (2017). Science Education Key Learning Area Curriculum Guide (Primary 1 - Secondary 6) 2017. Hong Kong: Curriculum Development Council. Retrieved April 8, 2021, from https://www.edb.gov.hk/attachment/en/curriculum-development/kla/science-edu/SEKLACG_ENG_2017.pdf

Dempsey, J. V., & Litchfield, B. C.(2015). Authentic assessment of knowledge, skills, and attitudes. *New Directions for Teaching and Learning*, *142*(142), 65-80.

Education Bureau of Government of HKSAR. (2016, December). *Report on Promotion of STEM Education - Unleashing Potential in Innovation* (Rep.). Retrieved April 8, 2021, from Education Bureau of Government of HKSAR website: https://www.edb.gov.hk/attachment/en/curriculum-development/renewal/STEM%20Education%20Report_Eng.pdf

Fortus, D & Vedder-Weiss, D. (2012). Adolescents' declining motivation to learn science: A follow-up study. *Journal of Research in Science Teaching, 49*(9), 1057-1095.

Fortus, D., & Touitou, I. (2021). Changes to students' motivation to learn science. *Disciplinary and Interdisciplinary Science Education Research*, *3*(1), 1-14.

Fung, A., Fung, J., Tai, H., & Tsang, J. (2017, September 25). *STEM+ Glocalization & Top-level*

Design of STEM Education (Rep.). Retrieved April 8, 2021, from 香港願景計劃 website: http://www.hkpri.org.hk/research/detail/stem

Government of Western Australia Department of Education. (n.d.). What is STEM? Retrieved April 08, 2021, from https://www.education.wa.edu.au/what-is-stem

Harackiewicz, J. M., Smith, J. L., & Priniski, S. J. (2016). Interest Matters: The Importance of Promoting Interest in Education. *Policy insights from the behavioral and brain sciences*, *3*(2), 220–227. https://doi.org/10.1177/2372732216655542

Hidi S, Harackiewicz JM (2000). Motivating the academically unmotivated: A critical issue for the 21st century. *Review of Educational Research.* 2000;79:151–179. doi: 10.2307/1170660.

Hoose, N. (n.d.). Interest as Motivation. Retrieved March 24, 2022, from https://courses.lumenlearning.com/edpsy/chapter/interest-as-motivation/

Kennedy, T. J., & Odell, M. R. L. (2014). Engaging students in STEM education. *Science Education International*, *25*(3), 246-258.

Lemos, M. S., & Veríssimo, L. (2014). The relationships between intrinsic motivation, extrinsic motivation, and achievement, along elementary school. *Procedia-Social and Behavioral Sciences*, *112*, 930-938.

Lepper, M. R., Sethi, S., Dialdin, D., & Drake, M. (1997). Intrinsic and extrinsic motivation: A developemental perspective. In S. S. Luthar, J. A. Burack, D. Cicchetti, & J. R. Weisz (Eds.), Developmental psychopathology: Perspectives on adjustment, risk, and disorder (pp. 23–50). New York, NY: Cambridge University Press.

Mullis, I. V. S., & Martin, M. O. (Eds.). (2019). *PIRLS 2021 Assessment Frameworks*. Retrieved from Boston College, TIMSS & PIRLS International Study Center website: https://timssandpirls.bc.edu/pirls2021/frameworks/

Neri, N. C., Guill, K., & Retelsdorf, J. (2019). Language in science performance: do good readers perform better?. *European Journal of Psychology of Education*, 1-17. https://doi.org/10.1007/s10212-019-00453-5

Nurmi, J. et al. (2003), "The role of success expectation and task-avoidance in academic performance and satisfaction: Three studies on antecedents, consequences and correlates", Contemporary Educational Psychology, Vol. 28/1, pp. 59-90, Retrieved 25 March, 2022, from http://dx.doi.org/10.1016/s0361-476x(02)00014-0.

OECD (2019), PISA 2018 Assessment and Analytical Framework, PISA, OECD Publishing, Paris,

Retrieved 20 March, 2022, from https://doi.org/10.1787/b25efab8-en.

OECD (2019), *What 15-year-old students in Hong Kong (China) know and can do*, PISA, OECD Publishing, Paris, Retrieved March 25, 2022, from https://www.oecd.org/pisa/publications/PISA2018_CN_HKG.pdf

OECD (2021), 21st-Century Readers: Developing Literacy Skills in a Digital World, PISA, OECD Publishing, Paris, Retrieved Dec 25, 2021, from https://doi.org/10.1787/a83d84cb-en

Mo, J. (2019), "How is students' motivation related to their performance and anxiety?", *PISA in Focus*, No. 92, OECD Publishing, Paris, Retrieved March 25, 2022, from https://doi.org/10.1787/d7c28431-en.

Paul, A. (2013, November 04). How the power of interest Drives Learning. Retrieved April 09, 2021, from https://www.kqed.org/mindshift/32503/how-the-power-of-interest-drives-learning

Schleicher, A. (2018). Insights and interpretations. *Pisa 2018*, *10*.

Renninger KA, Sansone C, Smith JL (2004). Love of learning. In: Peterson C, Seligman MEP, editors. *Character strengths and virtues: A handbook and classification.* New York, NY: Oxford University Press; 2004. pp. 161–179.

The Hong Kong Federation of Youth Groups Youth Research Centre. (2018, January). *STEM Education in Secondary Schools: Improving Resource Utilization* (No. 26). https://yrc.hkfyg.org.hk/wp-content/uploads/sites/56/2018/01/YI026_Report.pdf

Wentzel, K. R. (2020). *Motivating students to learn*. Routledge.

陳木金和許瑋珊(2012)：PISA 閱讀評量的國際比較探討閱讀素養教育的方向，《教師天地》，101，頁 4-15。

陳一銘和王文吟(2018)：營造良好學校閱讀環境的因素與策略探討，《臺灣教育評論月刊》，7(5), 頁 234-238。

何瑞珠、林智中和曾榮光(2020)：香港課改二十年的現狀與展望: 中學教師和校長的看法，《教育學報》,48(1), 頁 1-21.

麥瑞琪、薛寶嫦、楊文佳和張國祥(2019)：PISA 科學素養評核框架及評核模式之轉變審視澳門學生科學素養的性別差異趨勢，《測驗學刊》，66(3)，頁 249-284。

香港青年協會(2017)：《青年創研庫教育與創新研究系列「小學創科教育的狀況與啟示」研究報告》，香港，香港青年協會青年研究中心。

謝志成和張錦華(2015)：香港中學生在學生能力國際評估計劃 2012 的解難能力表現及其對教學的啟示，《教育學報 》，43(1) ，頁 85-101。

趙文浩(2020)：初探中學推動閱讀風氣的困難，檢自 https://hkeducatorsclub.medium.com/eduinsights0054-16c5f78f0d35，檢索日期 2022.3.27。

8. Section 8: Appendices

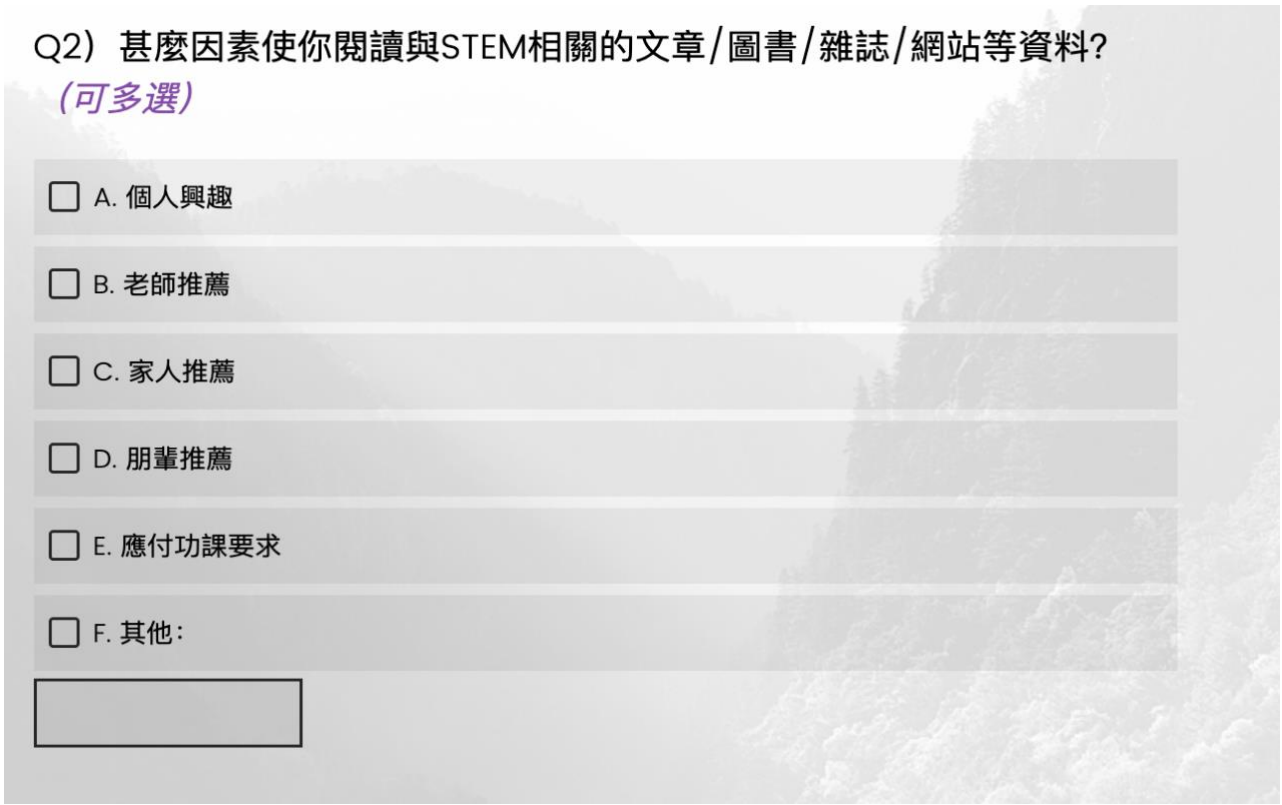
8.1. Questionnaire

第二部分 問卷

請細閱以下題目，並選出最貼合你的情況的選項。謝謝🙏

Q1) 在過去的一年，你閱讀與STEM相關的文章/圖書/雜誌/網站等資料的次數是多少?

- ○ A. 0-5次
- ○ B. 6-10次
- ○ C. 11-15次
- ○ D. 16-20次
- ○ E. 21-25次
- ○ F. 25次以上



Q2) 甚麼因素使你閱讀與STEM相關的文章/圖書/雜誌/網站等資料?
(可多選)

- ☐ A. 個人興趣
- ☐ B. 老師推薦
- ☐ C. 家人推薦
- ☐ D. 朋輩推薦
- ☐ E. 應付功課要求
- ☐ F. 其他:

Q3) 如題2的選項多於1，請按它們影響性由最大至最少(1:最大)進行排序。如題2的選項只有1項，請往題4。*(移動選項作答)*

- 個人興趣
- 老師推薦
- 家人推薦
- 朋輩推薦
- 應付功課要求
- 其他：
- 其他：
- 其他：

Q4) 以往的你在多大程度對閱讀STEM相關的文章/圖書/雜誌/網站等資料感興趣?

- ○ A. 非常不感興趣✗✗
- ○ B. 不感興趣✗
- ○ C. 感興趣✓
- ○ D. 非常感興趣✓✓

Q5) 甚麼因素影響你閱讀與STEM相關的文章/圖書/雜誌/網站等資料的興趣? *(可多選)*

- ☐ A. 內容的有趣度
- ☐ B. 內容的深淺度
- ☐ C. 畫面設計
- ☐ D. 書寫語言
- ☐ E. 資料的知名度
- ☐ F. 閱讀資料的所需時間
- ☐ G. 對提升課業表現的幫助
- ☐ 其他:

Q6) 在閱讀與STEM相關的文章/圖書/雜誌/網站等資料後(例如第一部分的閱讀材料), 你對STEM的興趣有否增加?

- ○ A. 有✓
- ○ B. 沒有✗

Q7) 你認為閱讀與STEM相關的文章/圖書/雜誌/網站等資料對你學習STEM相關學科 (科學/工程 / 科技/數學) 有多大程度的幫助?

- ○ A. 完全沒有幫助✗✗
- ○ B. 沒有幫助✗
- ○ C. 有幫助✓
- ○ D. 非常有幫助✓✓

8.2. Worksheet

Q2) 承上題，請解釋你的判斷。

Q3) 如你的判斷是碧婷體重過輕/過重，請列舉3個問題成因。

1.2 搜集資料：

中國每人每天平均所需的能量(千卡)參考值

	男			女		
7-10歲	1950			1850		
11-14歲	2650			2300		
15-18歲	2900			2400		
體力活動水平	輕	中	重	輕	中	重
18歲以上	2400	2700	3200	2100	2300	2700
50歲以上	2300	2600	3100	1900	2000	2200
60歲以上	1900	2200	不適用	1800	2000	不適用
70歲以上	1900	2100	不適用	1700	1900	不適用
80歲以上	不適用	1900	不適用	不適用	1700	不適用
女性：懷孕期加200千卡，哺乳期加500千卡						

我們也許會留意到每天平均所需的能量是因人而異的。亞洲人和西方人的體格各有不同，所需的能量也不同；發育中的兒童、青少年、懷孕和哺乳中的婦女，所需的能量較多；18歲以上人士隨著年齡的增長，能量的需求亦開始逐漸減少；活動量較大的人，能量的需求亦相對較高。我們可以按自己的年齡、性別、體重、活動量，在列表上找出每天的能量所需。可是，以上的參考值，並不一定能準確估計每一個人每天所需要的能量，這些數字只可作參考用途。

Q1) **根據以上圖表，** 碧婷每天需要的能量是多少千卡?

Q2）以下哪一表格顯示碧婷的不同基本食物的建議份量?
請瀏覽網址https://www.chp.gov.hk/tc/static/90017.html。

A
- 穀物類：1.5至3碗
- 蔬菜類：最少1.5份
- 水果類：最少1份
- 肉、魚、蛋及代替品：1.5至3兩
- 奶類及代替品：2份
- 油、鹽、糖類：吃最少
- 流質飲品：4至5杯

B
- 穀物類：3至4碗
- 蔬菜類：最少2份
- 水果類：最少2份
- 肉、魚、蛋及代替品：3至5兩
- 奶類及代替品：2份
- 油、鹽、糖類：吃最少
- 流質飲品：6至8杯

C
- 穀物類：4至6碗
- 蔬菜類：最少3份
- 水果類：最少2份
- 肉、魚、蛋及代替品：4至6兩
- 奶類及代替品：2份
- 油、鹽、糖類：吃最少
- 流質飲品：6至8杯

D
- 穀物類：3至8碗
- 蔬菜類：最少3份
- 水果類：最少2份
- 肉、魚、蛋及代替品：5至8兩
- 奶類及代替品：1至2份
- 油、鹽、糖類：吃最少
- 流質飲品：6至8杯

1.3 設計模型：

請瀏覽網址https://www.cfs.gov.hk/tc_chi/nutrient/index.php 內的食物營養搜尋器和食物營養計算器，為碧婷設計早午晚三餐的健康餐單。

早餐

午餐

晚餐

1.4 測試模型：

請使用網址https://www.cfs.gov.hk/tc_chi/nutrient/index.php 內的食物營養搜尋器或食物營養計算器，評估你的餐單。

Q1) 你設計的餐單能為碧婷提供多少能量？請列出每項膳食的能量，並計算能量總和。（記得寫單位！😊）

Q2a) 膳食能否為碧婷提供適當份量的能量？

○ 能✓

○ 不能✗

Q2b) 請解釋原因。（提示：指出餐單的能量總和 大於/ 等於/ 少於 碧婷每天所需的能量）*若兩者相距差不多可當作「等於」