A project entitled

Investigating the relationship between students' experiencing STEM education and their career intents at Hong Kong senior secondary schools

Submitted by

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Declaration

I, HON WAI KAM declare that this research report represents my own work under the supervision of Dr. Sun Daner, and that it has not been submitted previously for examination to any tertiary institution.

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Abstracts

STEM education has been proposed in Hong Kong since 2015; STEM refers to Science, Mathematics, Technology, and Engineering. In STEM education, three generic skills: Creativity, Collaboration skill and Problem-solving skill are especially pointed by EDB to nurture. To get insights of STEM education in Hong Kong, this research explores the relationship between students' experiencing STEM education and their career intents at Hong Kong senior secondary schools. Thus, the level of extents, factors, and STEM education process that affect students' career intents were explored and discussed in this study. In the study, online surveys designed based on Social Cognitive Career Theory and interviews were conducted to collect data. One factor Confirmatory Factor Analysis was used for analyzing the collected survey data. The result shows that STEM education affects students' career intents to a small extent but affects students' choice on elective subjects of HKDSE to a medium extent. Students may not change their career intents into STEM-related because they already had explicit career plans or the STEM experiences were not intensive enough and could not allow students to be confident and devote themselves to STEM-related careers. Improvements have to be made on the course design and arrangement in future STEM education.

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1. Introduction

STEM is an acronym for science, technology, engineering, and mathematics education and application in a traditional and specified discipline via an interdisciplinary, associative, and centripetal perspective (Caucus, 2010; English, 2019; Siekmann & Korbel, 2016). It aims to train students' critical thinking skills and solve problems creatively to become higher marketability in the workforce (Bybee, 2010). Students need to acquire STEM literacy such as complex social communication and interaction skills, creative problem-solving skills, adaptability, flexibility, system thinking, and self-management skills to compete in modern society and the economy (White, 2014).

The United States started the education reform after the production of Sputnik in the 1960s. It kept improving the education structure by producing science and mathematics standards for national education in the 1990s (Xie, Fang & Shauman, 2015). Other countries such as Taiwan, Finland, and Hungary have promoted STEM education in their education system. The students' performance is even better than the U.S students (Hanushek et al. as cited in Xie et al., 2015). To follow the international STEM education trends, the Hong Kong government proposed STEM education in 2015 and supported it in the upcoming years (EDB, 2016). The Education Bureau (EDB) collaborated with different stakeholders, such as tertiary institutions, technology enterprises, and non-governmental and professional organizations, to develop learning and teaching resources and programs for underpinning STEM education. The final goal is to cultivate the STEM literacy and gable perspectives of Hong Kong students to compete in the national and competitive 21st century (Geng, Jong & Chai, 2019).

In recent Hong Kong, there are several issues have been identified in STEM education. For example, some studies showed that the learning process and outcomes might differ on many factors like subjects, learning duration, and environmental conditions (Marton, Alba & Kun, 2014; OECD, 2018). Therefore, in STEM education, considering very few large scales of studies that have been conducted to examine the relationship between secondary school students' STEM education experience and their career intentions further to show the main factors of students' STEM intents. The study explored the factors, effects, and relationships between Hong Kong STEM education and senior secondary students' career intents.

In this study, international and local STEM education trends, STEM education, and careers with relevant studies were discussed in the literature review. Research purposes and questions were listed after the literature review. Then, the research methods were introduced further for presenting the methods, sampling, data collection and analysis, result and findings, discussion, conclusion, implication, and limitation.

2. Literature Review

2.1 The Status of STEM education

2.1.1 International trends of STEM education

Three events speed up the growth and development of STEM education. The earliest event was the Morrill Act in 1862, a land grant university that started to mix engineering and agricultural training to become technology-oriented. The following two events were World War II and the Soviet Union's Sputnik production and launch. The weaponry and vehicles like Atomic Bombs and tanks led to the attention of innovation based on science, mathematics, and engineering. The production and launch of Sputnik resulted in the United States started to consider and develop furthering technology on space travel and exploration (White, 2014). STEM education is the direct way to cultivate talented people for contributing to the above furthering technology (Kutnick et al., 2020).

Western countries have promoted STEM education much earlier than the other countries starting from the 1980s. The Australian government proposed the STEM policy in schools in 1987. The promotion of STEM education in Asian countries was slower than the western countries, but the history of STEM education or policy was still longer than that in Hong Kong (Kutnick et al., 2020). For example, Taiwan started to proposed STEM education in primary and secondary schools in 2001, and Malaysia has conducted STEM education for more than 15 years (Lin, 2018). In 2017, China announced that STEM education would be added to the primary school curriculum (National Institute of Education Sciences, 2017).

2.1.2 STEM education in Hong Kong

STEM education was first proposed in the 2015 Policy Address and was further supported in the 2016 Policy Address. There was a one-off grant to primary and secondary schools from the promotion of STEM education from 2016. In the Report on STEM Education – Unleashing Potential in Innovation published in 2016, the aims of STEM education in Hong Kong are listed as follows (EDB, 2016),

1) Cultivating students' interest in Science, Technology, and Mathematics,
2) Developing among students' a solid knowledge base,
3) Nurturing students' creativity, collaboration, and problem-solving skills,
4) Fostering students' innovation and entrepreneurial spirit.

EDB proposes six strategies for promoting STEM education in Hong Kong, they are,

1) Renew Science, Technology and Mathematics Education curriculums and key learning areas - add programming education in the subject of Information and Communication Technology,
2) Enrich STEM-related Learning Activities for Students with financial support,
3) Provide STEM-related Learning and Teaching Resources - develop websites, competitions, and education centers for schools,
4) Enhance Professional Development of Schools and Teachers - provide STEM-related advanced studies and international exchange,
5) Strengthen Partnerships with Community Key Players - cooperate with local and worldwide universities, professional bodies, and other government and non-governmental organizations,
6) Conduct Review and Disseminate Good Practices - collect contents and outcomes of successful STEM courses and programs for demonstration and inspiration

To review the implementation of STEM education in the past few years and propose suggestions to enhance the STEM education curriculum for the future, a Task Force on School Curriculum Review was developed in 2017 and made feedbacks and recommendations to the government in 2019. The UGC-funded universities also suggest proposing more STEM-related and cross-disciplinary programs, such as financial technology and artificial intelligence in the following academic years (Kutnick et al., 2020).

2.2 STEM careers and the relevant studies

STEM careers ordination can be divided into two types, “Applied” STEM majors such as engineering and computer science. Another type is not for “pure” STEM majors such as biology, chemistry, and mathematics (Deming and Noray, 2018). The STEM-related programs help college graduates transform into a capable workforce smoothly. However, Deming and Noray claimed that technology develops and changes rapidly. This may lead to technological skills becoming obsolete. Policymakers and educators have to get the balance between general skills and technology-specific skills for the next generation.

From the research done by Wiebe, Unfried, and Faber in 2018, STEM education could form the attitudinal association between students’ academic and life experience and future STEM careers. The gaps between students, including genders, financial and social status, were reduced after they gained STEM education, and the willingness to choose STEM-related careers increased. (Christensen and Knezek, 2017)

There are more STEM educational resources globally, but fewer students tended to choose STEM careers in Hong Kong. EDB defined STEM-related programs including physical science, biological science, computer science and information technology, mathematical science, architectural studies and town planning, engineering, and technology (EDB, 2016). The following table showed the students intake of UGC-funded STEM-related undergraduate programs from 2013/14 to 2017/18 academic years (Legislative Council, 2018),

Table 1 Numbers of students intake of UGC-funded STEM-related undergraduate programs from 2013/14 to 2017/18 academic years

Academic year	Student intake
2013/14	5886
2014/15	6155
2015/16	6304

2016/17	6565
2017/18	6780

There is an increasing trend of students intake STEM-related majors after promoting STEM education and these students may engage in STEM industries after graduation. (Legislative Council, 2018)

3. Research Purpose and questions

3.1 Research Purpose

This research focuses on examining the effect of students' experience of STEM education on their career intents. It includes the extension and process of STEM education affecting senior secondary school students' career intents in Hong Kong.

3.2 Research questions

1. To what extent does STEM education affect the career intent of senior secondary school students in Hong Kong?
2. How does STEM education affect the career intent of senior secondary school students in Hong Kong?
3. Why senior secondary school students change their career intent after gaining STEM courses?
4. Why senior secondary school students do not change their career intent after gaining STEM courses?

4. Research method

4.1 Participants

In this study, 200 from 4-6 students participated in the online survey, and 5 students were interviewed. Ethical approval had been obtained from the participants and their schools. The target participants were Hong Kong senior secondary school students with STEM education experiences in the past. There are three secondary school banding in Hong Kong. The ideal ratio of each banding was 1:1:1. The age of participants was between 14 to 17. And the majority of the race were Chinese and then Indonesian, Filipino, White, and others.

4.2 Data sources

The research used both qualitative and quantitative methods. An online survey designed with a Likert-type scale was used to collect quantitative data, while an interview designed with open-ended questions was used to collect qualitative data.

4.2.1 Hong Kong Student STEM Career Interest Survey

The survey focused on the relationship between students' experiencing STEM education and their career intents at Hong Kong senior secondary schools. Participants took the survey online using a smartphone, a tablet, or a computer within 10 to 15 minutes.

The career intents related part of the survey is designed based on the STEM Career Interest Survey (STEM-CIS), which was developed by Kier, Blanchard, Osborne, and Albert in 2013. STEM-CIS survey has been adopted by many studies (Clark and Watson as cited in Kier et al., 2014; UNLU, Dokme & Veli, 2016). STEM-CIS was developed under critical aspects of the Social Cognitive Career Theory (SCCT), such as personal inputs, contextual influences proximal to choices, self-efficacy, background or context, and outcome expectations, explaining how these elements affect the career-related decisions making of individuals. Lent et al. (1994) connected Bandura's (1986) relationship between self-efficacy, outcome expectations and goals to contextual factors, personal inputs and interests to explain how individuals make career-related decisions (see Fig. 1).

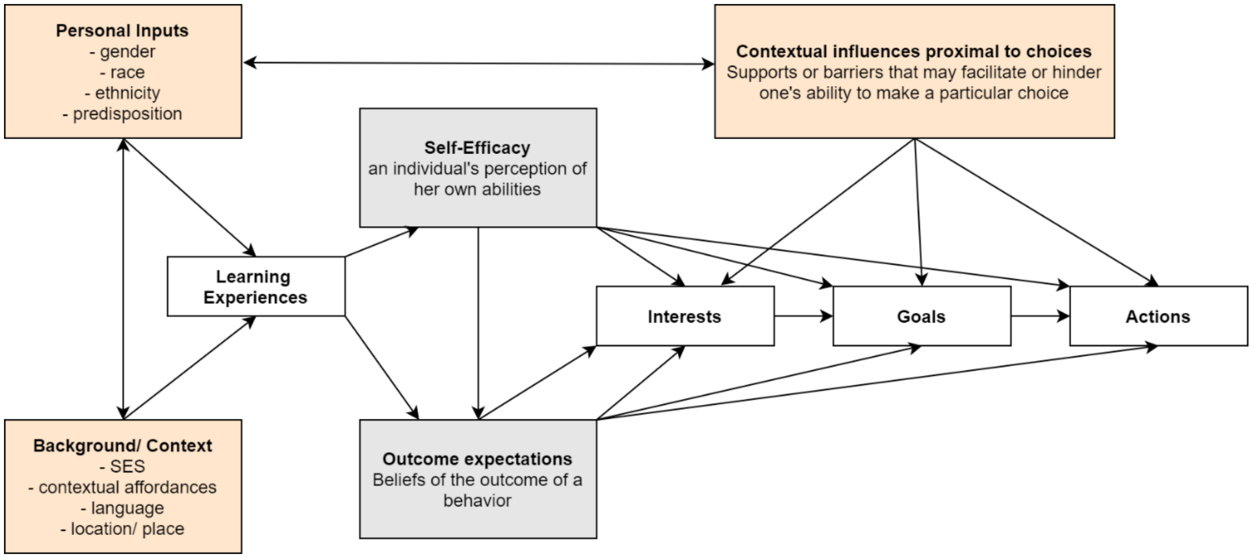

Fig. 1 The social cognitive career theory (Lent et al. 1994, 2000)

In the figure, gender, background, race, and socioeconomic status are the examples of socially constructed factors in personal inputs and personality, contribution to own feelings of high or low self-efficacy are the intrapersonal factors. Contextual supports and barriers are the external factors that impede or facilitate high self-efficacy or regulating academic or career goals. This framework has been used by many studies to encourage initiating these key aspects to be more relevant to the population (Gushue 2006; Lent et al. 2008 as cited in Kier et al., 2014).

4.3 Scale Development

There are six stages for developing scale items. (Clark and Watson as cited in Kier et al., 2014) To adapt to the situation of STEM education in Hong Kong, some adjustments were made during the development of the career intents survey part of this study as the following:

Stage 1	Conduct a literature review for developing scale items
Stage 2	Develop various scale items for testing the target aspect
Stage 3	Preliminary items testing

Stage 1: Conduct a literature review for developing scale items

The literature review uses Google Scholar and JSTOR to search the literature that inscribing students' interests in STEM, STEM-related careers, and the sentience of STEM professionals in

Hong Kong and worldwide. The social cognitive career theory was applied to different STEM fields (Kier et al., 2014).

Stage 2: Develop various scale items for testing the target aspect

Draft statements for scaling are developed based on the six SCCT aspects include self-efficacy, personal goals, outcome expectations, interest, personal inputs and contextual supports and barriers. Based on the items of STEM-CIS and the learning objectives of STEM education in Hong Kong, there were seven dimensions identified: science, mathematics, technology, engineering, creativity, collaborative skills and problem-solving skills (EDB,2016; Liu, 2020; Wong, Dillon & King, 2016; Sen, Ay & Kiray, 2018). The examples of the statements are shown in the following table.

Table 2 Examples of SCCT statements

SCCT aspects measured	Hong Kong STEM education aspects measured	Example statement
Self-efficacy	Problem-solving skill	I am able to suggest different methods to solve problems.
Personal goals	Technology	I plan my future career will be related to technology.
Outcome expectations	Mathematics	My future career can be enhanced if I do well in mathematics class.
Interest	Creativity	I think careers that required creativity is interesting.
Personal inputs	Engineering	I feel comfortable when talking to people who are working in the engineering field.
Contextual supports and barriers	Science	There are relatives who use science in their careers.

Stage 3: Preliminary items testing

Based on STEM-CIS, a five-point Likert-type scale has been used for this study. Participants need to select the most appropriate description: Strongly Disagree (1), Disagree (2), Neither Agree nor Disagree (3), Agree (4), Strongly Agree (5) for the statements which were associated with the six aspects of the social cognitive career theory. These statements were reviewed by five STEM-related subjects teachers and were understandable to secondary school students. These scale items were distributed to 5 senior secondary students from three different banding schools (Band1, 2 and 3) for evaluating the appropriateness of the statements. The result collected in this stage were not counted as the final result for the study. Students used about 10 to 15 minutes to complete the whole online survey. Only a few proper nouns were changed to wordings that secondary students earlier understood, and more clear definitions were given, such as, standard definitions and careers of technology in Hong Kong, and “exemplar” became “model”.

Finally, the Hong Kong Student STEM Career Interest Survey has been finalized as Appendix1 shows two sections; section 1 is about participants’ demographics with 12 items regarding students’ gender, grade, and school banding (Hughes, Camden & Yangchen, 2016; Suprapto, 2016). And section 2 is the main section asking students’ self-efficacy, personal goals, outcome expectations, interest, personal inputs, and contextual supports and barriers on science, mathematics, technology, engineering, creativity, collaborative skills, and problem-solving skills for each dimension with 11 items.

4.4 Data collection and analysis

The survey was distributed online and the Google form was used for collecting data starting from November 2020 to February 2021. The collected data was used to analyze students' career intents' trends and relationships after experiencing STEM education and the other factors affecting their career intents. The survey was distributed online as the cost and time are low and can access unique populations like senior secondary students required for this research (Wright, 2005). And it can collect data from large amounts of samples with different question types, such as true/ false options, multiple-choice options, and response scale options for analysis easily (Lietz, 2010).

Confirmatory factor analysis (CFA) is a factor analysis with a firm idea about the number of factors encountered and about which variables would be most likely loaded onto each factor (Malkanthie, 2018). Performing Confirmatory Factor Analysis (CFA) is a popular statistical method that can support validating the structure of psychological analysis literature (Harrington, 2009). CFA can verify the properties of each subscale psychologically. In this study, SPSS software was the analysis tool for the quantitative method. AMOS is a structural formula modeling software produced with SPSS. AMOS can take advantage of parts of information from different cases while not all completed data is required and cases with incomplete data would not be deleted during analysis (Kier et al., 2014). And AMOS was used to conduct the Confirmatory Factor Analysis (CFA) for the above seven aspects. Therefore, the data collected from the survey will use CFA through AMOS with SPSS as the analysis method for the study.

For the interview, 5 participants were selected randomly from the survey part and invited to do individual interviews in Cantonese, which took about 10 to 15 minutes after over 150 valid surveys were collected. Only audio was recorded for the interview. Participants shared their past STEM experiences and feelings in the interview. The effects and extents of STEM experiences on students' choice on elective subjects Hong Kong Diploma of Secondary Education (HKDSE), career intents, academic performances and personal growth were asked in the interview. The interview focused on each individual's experience and opinion and then elaborated on the ordinary process of how students' career intents were affected or not affected by the STEM education experiences.

5. Result and findings

5.1 Demographics

There were 200 valid surveys for the qualitative data. The following charts are showing the background information of the survey participants.

5.1.1 Characteristics of participants' gender, grade, school banding

Based on data analysis, 66.7% of participants (104 participants) were female and 33.3% participants 52 participants) were male.

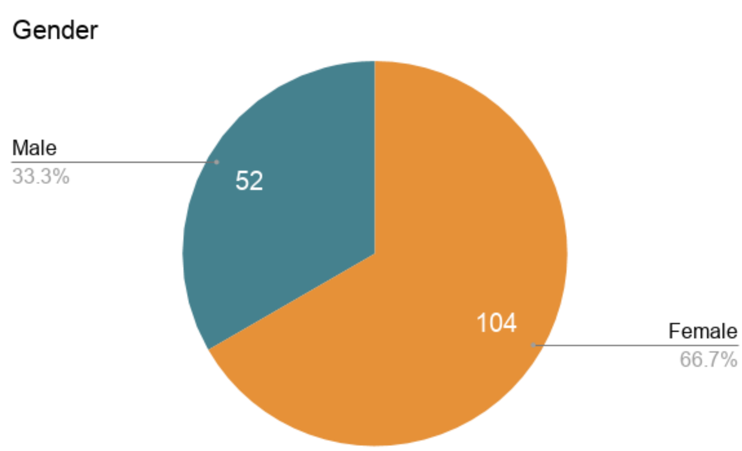

Fig. 2 Pie chart for survey participants' gender

There are 47% of participants (94 participants) were form 6 students, 30% of participants (60 participants) were form 5 students, and 23% of participants (46 participants) were form 4 students.

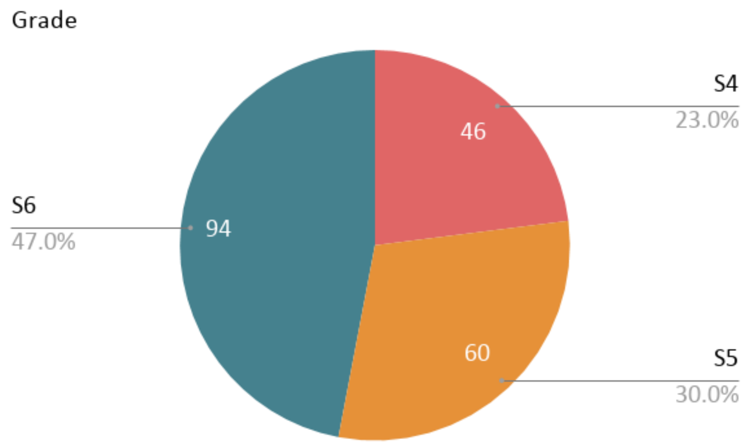

Fig. 3 Pie chart for survey participants' grade

There are 46.5% of participants (93 participants) were from band 1 secondary schools, 32.5% of participants (65 participants) were from band 2 secondary schools, and 21% of participants (42 participants) were from band 3 secondary schools.

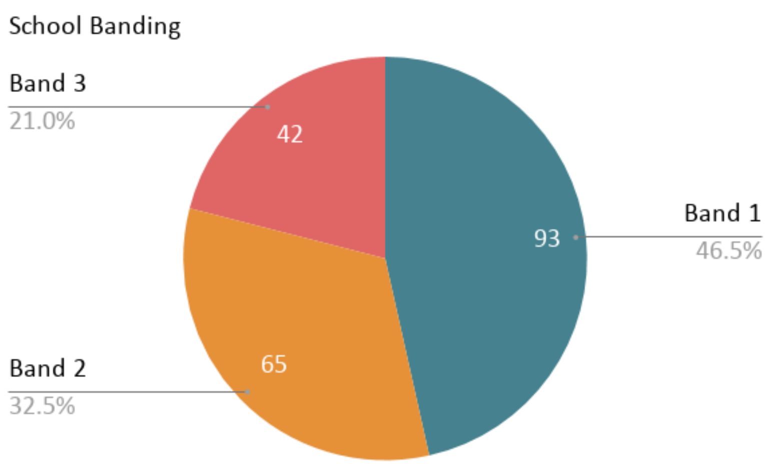

Fig. 4 Pie chart for survey participants' school banding

The most popular elective subjects were Chemistry (more than 50% of participants chose it as one of the elective subjects for HKDSE), Biology (35% of participants chose it as one of the elective subjects for HKDSE), and Physics (25.9% of participants chose it as one of the elective subjects for HKDSE).

To summarize the above, the majority of this survey were form 6 students from band 1 schools and mainly studied science-related subjects.

5.1.2 Characteristics of participants' experience in stem education: level of understanding, duration and frequency

The following charts are showing the data of survey participants on STEM experience, including the level of understanding of STEM, frequency and duration of taking STEM classes, projects and activities.

There were 93% of participants (186 participants) who said that they had experience in STEM education and only 7% of them (14 participants) said that they did not have any experience in STEM education.

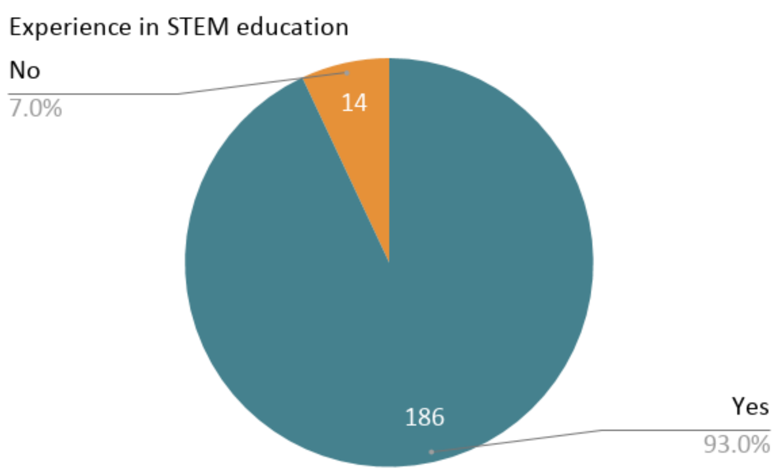

Fig. 5 Pie chart for survey participants' experience in STEM education

There were over 90% of participants claimed that their level of understanding of STEM is high (45.5%, 91 participants) and medium (48%, 96 participants). There were less than 10% of participants claimed that they did not know much about STEM.

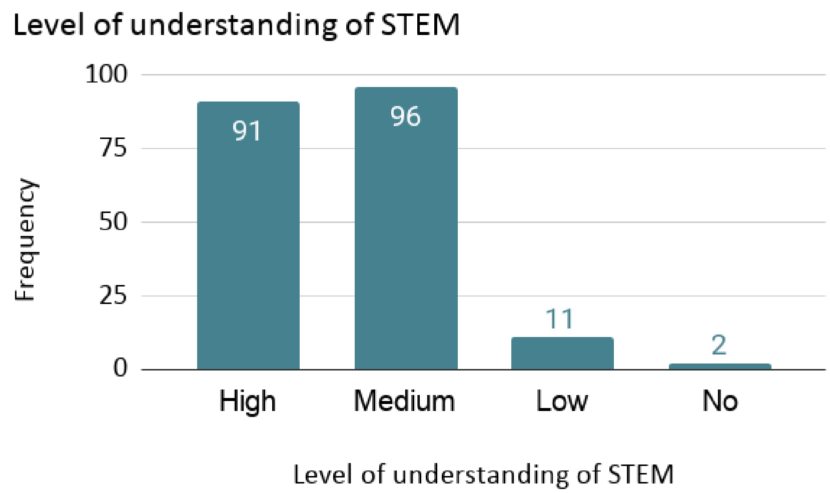

Fig. 6 Bar chart for survey participants' experience in STEM education

From the chart, there were about 70% of participants (128 of 186 participants who have STEM experiences before) claimed that they had experienced STEM education like class, course, activity, or project for more than two years. Only 15% of participants (18 of 186 participants who have STEM experiences before) said they had experienced STEM education from half-year to one year.

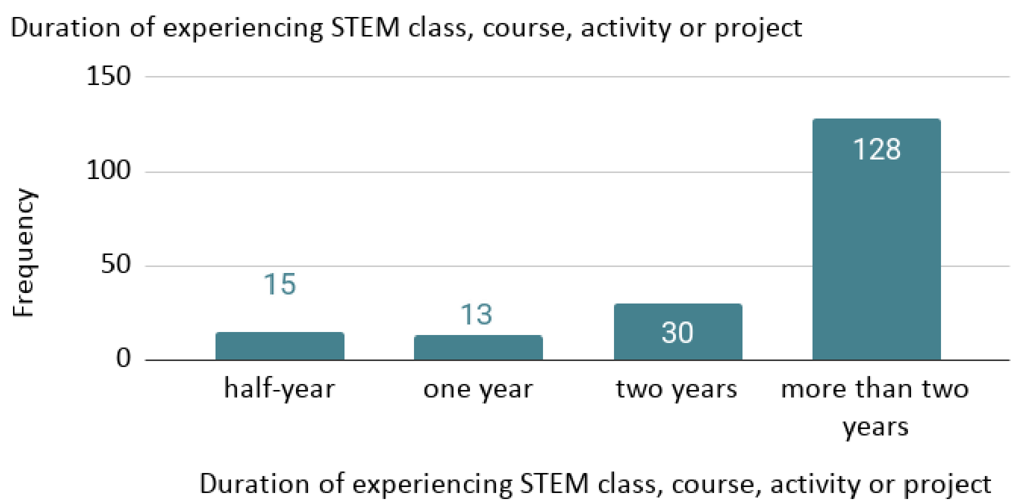

Fig. 7 Bar chart for survey participants' duration of experiencing STEM education

60.2% of participants (112 of 186 participants who have STEM experiences before) claimed that they take STEM classes, courses, activities, or projects once a week. And 13% of them said that they have STEM classes more than five times a week. This showed an extreme situation of students' frequency of experiencing STEM education that students attend STEM class in an extremely high or low frequency.

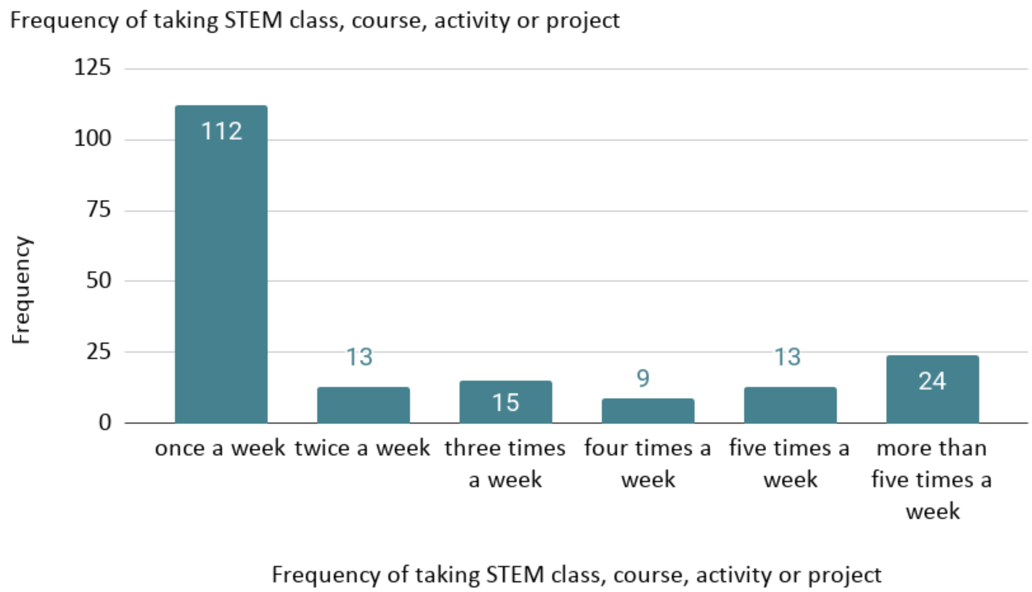

Fig. 8 Bar chart for survey participants' frequency of experiencing STEM education

The above data show the implementation of STEM education in Hong Kong was successful in these recent years as more than 90% of participants had experience in STEM education and more than 60% of participants experienced STEM education for more than two years.

5.2 Results of STEM career intents survey

5.2.1 Overall performance

The mean and standard deviation of seven Hong Kong STEM-related aspects (Science, Mathematics, Technology, Engineering, Creativity, Collaborative skill and Problem-solving skill) of the survey are shown in the following tables. Each table includes item numbers, the mean and standard deviation of each item, the aspect of Social Cognitive Career Theory that item belongs to, and the statement of each item. There are six SCCT aspects: self-efficacy, personal goal, outcome expectation, interest, contextual support, and personal input.

5.2.2 students' SCCT aspects of science in STEM education

As Table 3 shows, in the science career intent aspect, the highest mean score item is "If I choose a science-related career, my parents will appreciate it." (mean = 3.84, standard deviation = 0.798), which belongs to the "Outcome expectation" of SCCT aspect. The lowest mean score item is "I feel comfortable when talking to people who are working in science-related fields." (mean = 2.28, standard deviation = 0.731), which belongs the "Personal input" of SCCT aspect.

Table 3 Result of STEM career intents survey in Science

Item number	Mean	Std. Deviation	SCCT aspect	Item
Science1	3.41	1.052	Self-efficacy	I can get a fine score in science-related subjects.
Science2	3.65	1.070	Self-efficacy	I can finish my science-related assessments.
Science3	3.32	1.205	Personal goal	I plan my future career will be science-related.
Science4	3.41	1.130	Personal goal	I make efforts in science-related subjects.
Science5	3.41	1.165	Outcome expectation	My future career can be enhanced if I do well in science-related subjects.
Science6	3.84	0.798	Outcome expectation	If I choose a science-related career, my parents will appreciate it.
Science7	3.28	1.052	Interest in science	I think careers that use science is interesting.
Science8	3.29	1.172	Interest in science	I like to study science-related subjects.
Science9	2.40	0.929	Contextual support	I have a model in science-related fields.
Science10	2.28	0.731	Personal input	I feel comfortable when talking to people who are working in science-related fields.
Science11	2.60	1.147	Contextual support	There are relatives who use science in their careers.

5.2.3 students' SCCT aspects of mathematics in STEM education

As Table 4 shows, in the mathematics career intent aspect, the highest mean score item is "I can finish my mathematics assessments." (mean = 4.14, standard deviation = 0.709), which belongs to the "Self-efficacy" of SCCT aspect. The lowest mean score item is "I have a model in mathematics fields." (mean = 2.28, standard deviation = 0.688), which belongs the "Contextual support" of SCCT aspect.

Table 4 Result of STEM career intents survey in Mathematics

Item number	Mean	Std. Deviation	SCCT aspect	Item
Mathematics1	3.70	0.716	Self-efficacy	I can get a fine score in mathematics.
Mathematics2	4.14	0.709	Self-efficacy	I can finish my mathematics assessments.
Mathematics3	3.59	0.858	Personal goal	I plan my future career related to mathematics.
Mathematics4	3.92	0.718	Personal goal	I make efforts in mathematics class.
Mathematics5	3.82	0.775	Outcome expectation	My future career can be enhanced if I do well in mathematics class.
Mathematics6	3.86	0.837	Outcome expectation	If I choose a career related to mathematics, my parents will appreciate it.
Mathematics7	3.35	0.837	Interest in mathematics	I think careers that use mathematics is interesting.
Mathematics8	3.36	0.982	Interest in mathematics	I like to study mathematics.
Mathematics9	2.28	0.688	Contextual support	I have a model in mathematics fields.
Mathematics10	2.29	0.683	Personal input	I feel comfortable when talking to people who are working in mathematics fields.
Mathematics11	2.57	0.975	Contextual support	There are relatives who use mathematics in their careers.

5.2.4 students' SCCT aspects of technology in STEM education

As Table 5 shows, in the technology career intent aspect, the highest mean score item is "Learning about different technologies can help me develop in different types of careers." (mean = 4.21, standard deviation = 0.780), which belongs to the "Outcome expectation" of SCCT aspect. The lowest mean score item is "I feel comfortable when talking to people who are working in the technology fields." (mean = 2.56, standard deviation = 0.761), which belongs the "Personal input" of SCCT aspect.

Table 5 Result of STEM career intents survey in Technology

Item number	Mean	Std. Deviation	SCCT aspect	Item
Technology1	3.81	0.766	Self-efficacy	I can do well in technology involved activities.
Technology2	4.07	0.737	Self-efficacy	I can learn about new technologies.
Technology3	4.03	0.871	Personal goal	I plan my future career will be related to technology.
Technology4	4.14	0.855	Personal goal	I am interested in learning about new technology which helps me in school.
Technology5	4.21	0.780	Outcome expectation	Learning about different technologies can help me develop in different types of careers.
Technology6	3.99	0.848	Outcome expectation	If I choose a career related to technology, my parents will appreciate it.
Technology7	4.16	0.853	Interest in technology	I like using technology to finish my assignments.
Technology8	4.14	0.849	Interest in technology	I think careers that include a specific kind or different kinds of technology is interesting.
Technology9	2.66	0.806	Contextual support	I have a model in technology fields.
Technology10	2.56	0.761	Personal input	I feel comfortable when talking to people who are working in the technology fields.
Technology11	3.13	1.081	Contextual support	There are relatives who use technology in their careers.

5.2.5 students' SCCT aspects of engineering in STEM education

As Table 6 shows, in the engineering career intent aspect, the highest mean score item is "If I choose a career related to engineering, my parents will appreciate it." (mean = 3.38, standard deviation = 0.806), which belongs to the "Outcome expectation" of SCCT aspect. The lowest mean score item is "I feel comfortable when talking to people who are working in the engineering fields." (mean = 2.56, standard deviation = 0.761), which belongs the "Personal input" of SCCT aspect.

Table 6 Result of STEM career intents survey in Engineering

Item number	Mean	Std. Deviation	SCCT aspect	Item
Engineering1	2.89	0.765	Self-efficacy	I can do well in engineering involved activities.
Engineering2	3.09	0.837	Self-efficacy	I can complete the engineering involved activities.
Engineering3	2.77	0.902	Personal goal	I plan my future career related to engineering.
Engineering4	2.77	0.897	Personal goal	I make efforts in engineering involved activities at school.
Engineering5	2.81	0.932	Outcome expectation	Learning about different engineering can help me develop in different types of careers.
Engineering6	3.38	0.806	Outcome expectation	If I choose a career related to engineering, my parents will appreciate it.
Engineering7	2.66	0.899	Interest in engineering	I like engineering involved activities.
Engineering8	2.67	0.822	Interest in engineering	I think careers that use engineering is interesting.
Engineering9	2.21	0.652	Contextual supports	I have a model in the engineering fields.
Engineering10	2.16	0.719	Personal input	I feel comfortable when talking to people who are working in the engineering fields.
Engineering11	2.51	1.037	Contextual supports	There are relatives who use engineering in their careers.

5.2.6 students' SCCT aspects of creativity in STEM education

As Table 7 shows, in the creativity-related career intent aspect, the highest mean score item is "I think careers requiring creativity is interesting." (mean = 3.54, standard deviation = 0.801), which belongs to the "Interest in creativity" of SCCT aspect. The lowest mean score item is "I can develop alternative methods to test the model or creation." (mean = 2.46, standard deviation = 0.693), which belongs the "Self-efficacy" of SCCT aspect.

Table 7 Result of STEM career intents survey in Creativity

Item number	Mean	Std. Deviation	SCCT aspect	Item
Creativity1	3.38	0713	Self-efficacy	I am a creative person.
Creativity2	3.36	0.919	Self-efficacy	I always have unique ideas that others may not have.
Creativity3	3.01	0.913	Self-efficacy	I can apply new methods into solving problems creatively.
Creativity4	2.61	0.742	Self-efficacy	I can design new inventions to solve problems creatively.
Creativity5	2.49	0.730	Self-efficacy	I am able to build my model or creation solve problems in real life creatively.
Creativity6	2.57	0.712	Self-efficacy	I will test the model or creation continuously.
Creativity7	2.46	0.693	Self-efficacy	I can develop alternative methods to test the model or creation.
Creativity8	3.74	0.773	Self-efficacy	I can present my idea to others with clear and creative methods.
Creativity9	2.48	0.617	Self-efficacy	I can implement or integrate the model or creation in new context.
Creativity10	3.54	0.801	Interest in creativity	I think careers requiring creativity is interesting.
Creativity11	2.93	0.883	Personal goal	I plan my future career related to or required for creativity.

5.2.7 students' SCCT aspects of collaborative skills in STEM education

As Table 8 shows, in the collaborative skill-related career intent aspect, the highest mean score item is "I usually get high marks in activities which required for collaborative skill." (mean = 4.16, standard deviation = 0.766), which belongs to the "Self-efficacy" of SCCT aspect. The lowest mean score item is "I feel excited when group projects or assignments are assigned." (mean = 3.27, standard deviation = 0.921), which belongs the "Self-efficacy" of SCCT aspect.

Table 8 Result of STEM career intents survey in Collaborative skill

Item number	Mean	Std. Deviation	SCCT aspect	Item
Collaborativeskill1	3.72	0.731	Interest in collaborative skill	I like collaborating with others to complete tasks.
Collaborativeskill2	3.70	0.765	Interest in collaborative skill	I like working with others to complete tasks.
Collaborativeskill3	3.80	0.759	Self-efficacy	I like sharing ideas with others to complete tasks.
Collaborativeskill4	3.91	0.822	Self-efficacy	I like listening to others' ideas to complete tasks.
Collaborativeskill5	3.27	0.921	Personal input	I feel excited when group projects or assignments are assigned.
Collaborativeskill6	3.88	0.677	Personal goal	I make efforts in activities which required for collaborative skills at school.
Collaborativeskill7	4.16	0.766	Self-efficacy	I usually get high marks in activities which required for collaborative skill.
Collaborativeskill8	3.62	0.800	Personal input	I feel comfortable when collaborating with others.
Collaborativeskill9	3.59	0.797	Personal input	I feel comfortable when coordinating with others.
Collaborativeskill10	3.49	0.702	Interest in collaborative skill	I think careers that required collaborative skill is interesting.
Collaborativeskill11	3.47	0.795	Personal goal	I plan my future career related to and required for collaborative skill.

5.2.8 students' SCCT aspects of collaborative skills in STEM education

As Table 9 shows, in the problem-solving skill-related career intent aspect, the highest mean score item is "I feel successful after the problem was solved." (mean = 4.34, standard deviation = 0.645), which belongs to the "Personal input" of SCCT aspect. The lowest mean score item is "I like challenges." (mean = 2.83, standard deviation = 0.859), which belongs the "Interest in problem solving skill" of SCCT aspect.

Table 9 Result of STEM career intents survey in Problem-solving skill

Item number	Mean	Std. Deviation	SCCT aspect	Item
Problemsolvingskill1	3.74	0.589	Self-efficacy	I am able to find problems.
Problemsolvingskill2	3.79	0.654	Self-efficacy	I am able to identify the factors of problems.
Problemsolvingskill3	3.51	0.737	Self-efficacy	I am able to suggest different methods to solve problems.
Problemsolvingskill4	3.95	0.714	Self-efficacy	I am able to evaluate the most appropriate method to solve problems.
Problemsolvingskill5	4.07	0.760	Self-efficacy	I am able to solve problems in a timely manner.
Problemsolvingskill6	4.34	0.645	Personal input	I feel successful after the problem was solved.
Problemsolvingskill7	3.70	0.796	Personal input	I feel comfortable when solving problems.
Problemsolvingskill8	3.05	0.816	Personal input	I am not afraid of facing challenges.
Problemsolvingskill9	2.83	0.859	Interest in problem solving skill	I like challenges.
Problemsolvingskill10	3.31	0.690	Interest in problem solving skill	I think careers requiring problem-solving skill is interesting.
Problemsolvingskill11	3.26	0.695	Personal goal	I plan my future career related to and required for problem-solving skill.

5.3 Findings of Confirmatory Factor Analysis

Comparative fit index (CFI) and normed fit index (NFI) indicate a good model fit if they are equal to or above 0.90. It will be an excellent model fit if CFI and NFI are close to 1. The Root Mean Square Error of Approximation (RMSEA) indicates a proper fit if the value is smaller than 0.11 and a good model fit if the value is less than 0.05 about freedom degrees (Shek and Yu, 2014). Chi-square is the chi-square statistic obtained from the maximum likelihood statistic.

5.3.1 Overall Performance

According to Table 10, the model was summarized. Almost all the seven aspects model was strong, and 4 of them (Science, Technology, Engineering, and Collaborative skill) were in good model fit. This reflects these models were acceptable and valid.

Table 10 Summary of confirmatory factor analyses

	Parameters estimated	df	Chi square	CMIN/df	NFI	CFI	RMSEA
Science (N=200)	27	39	74.912	1.921	.975	.988	.068
Mathematics (N=200)	27	39	183.481	4.705	.889	.909	.136
Technology (N=200)	29	37	80.371	2.172	.970	.984	.077
Engineering (N=200)	26	40	83.559	2.089	.946	.981	.074
Creativity (N=200)	30	36	160.756	4.465	.971	.934	.132
Collaborative skill (N=200)	26	40	101.620	2.541	.951	.970	.088
Problem-solving skill (N=200)	28	38	130.003	3.421	.900	.926	.110

For analyzing each dimension, One Factor Confirmatory Factor Analysis is used for this research. It assumes that the covariance or correlation among items is due to a single common factor. Factor loading and correlation are shown in the following figures. Factor loading is the number between factor and scale item, which weights of observed variables that determine the latent variables (Malkanthie, 2018). Factor loading may larger than 1 that represents there is a high degree of multicollinearity (Jöreskog, 1999). The path linked with two scale items is correlation which means those scale items are not generally interpreted substantively (Clark and Watson as cited in Kier et al., 2014). The meaning of the linked pair items may overlap, so the error correlations are included in the re-specified model (Shek and Yu, 2014). For example, in Fig. 9, a regression path from errors items e1 to e2 both talk about students' self-efficacy, and items e7 and e8 both are about students' interest in science. For those linked pair items that do not belong to the same aspects, the correlation between them represents those items that account for that additional shared variance. The residuals share variance because of the causes not accounted for by the alienation latent factors (Shek and Yu, 2014).

5.3.2 Result of One Factor Confirmatory Factor Analysis in science

In Figure 9, a correlation between errors items e1 and e2 both linked with students' self-efficacy. And a correlation between errors items e7 and e8 both are talking about students' interest in science. The correlations between e3 with e5, e6 with e10, and e9 with e10 account for that additional shared variance. These pair items share variance due to causes not accounted for by the alienation latent factors.

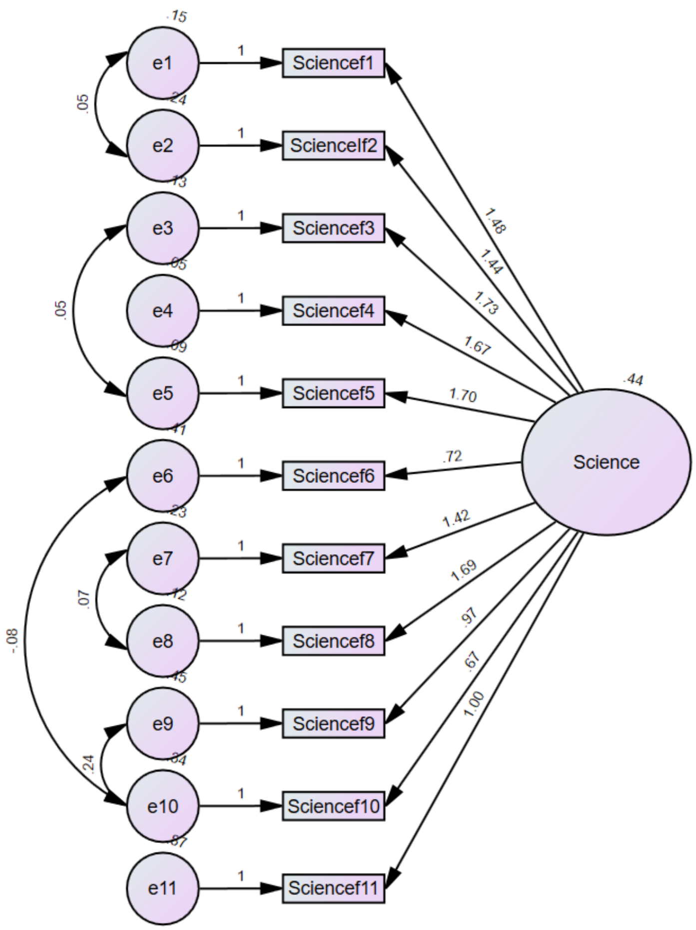

Fig. 9 Confirmatory factor analysis for Science

5.3.3 Result of One Factor Confirmatory Factor Analysis in Mathematics

In Figure 10, the correlations between e3 with e9, e4 with e7, e6 with e10, e9 with e10, and e10 with e11 account for that additional shared variance. These pair items share variance due to causes not accounted for by the alienation latent factors.

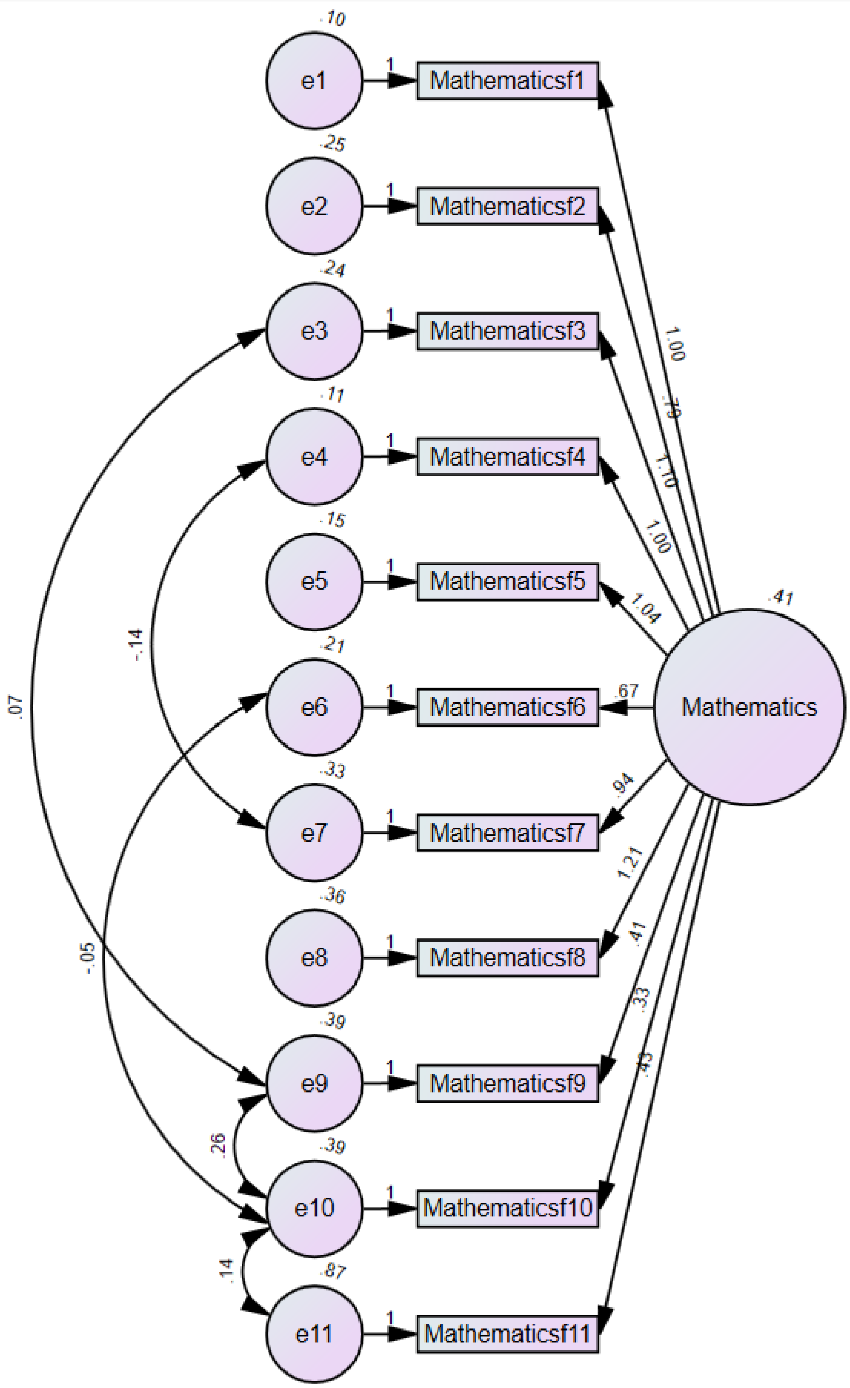

Fig. 10 Confirmatory factor analysis for Mathematics

5.3.4 Result of One Factor Confirmatory Factor Analysis in Technology

In Figure 11, a correlation between errors items e1 and e2 both linked with students' self-efficacy. The correlations between e1 with e3, e1 with e10, e2 with e3, e4 with e5, e9 with e10, and e10 with e11 account for that additional shared variance. These pair items share variance due to causes not accounted for by the alienation latent factors.

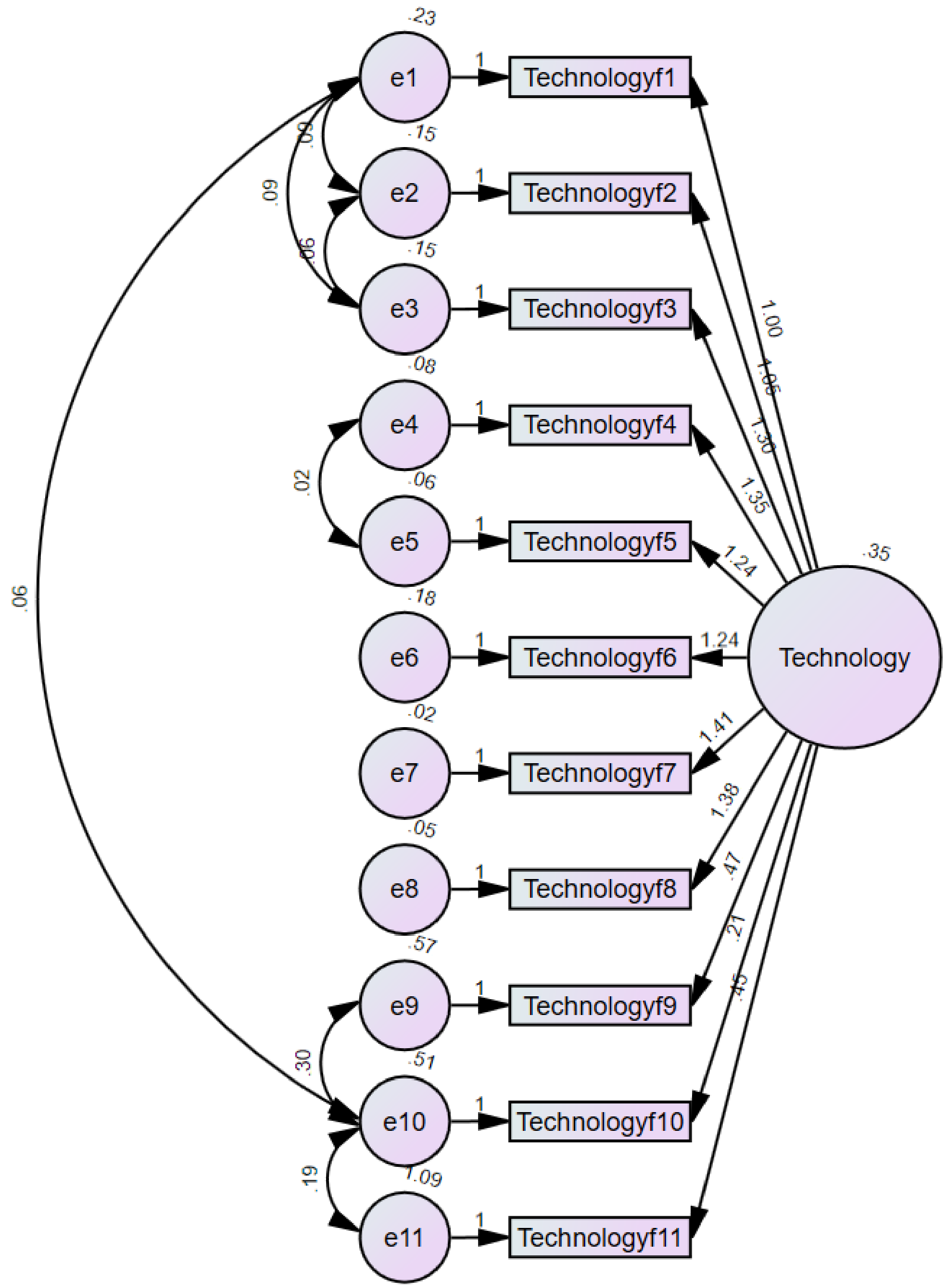

Fig. 11 Confirmatory factor analysis for Technology

5.3.5 Result of One Factor Confirmatory Factor Analysis in Engineering

In Figure 12, a correlation between errors items e7 and e8 both linked with students' interest in engineering. And a correlation between errors items e9 and e11 both are talking about students' contextual supports and barriers. The correlations between e9 with e11 account for that additional shared variance. These pair items share variance due to causes not accounted for by the alienation latent factors.

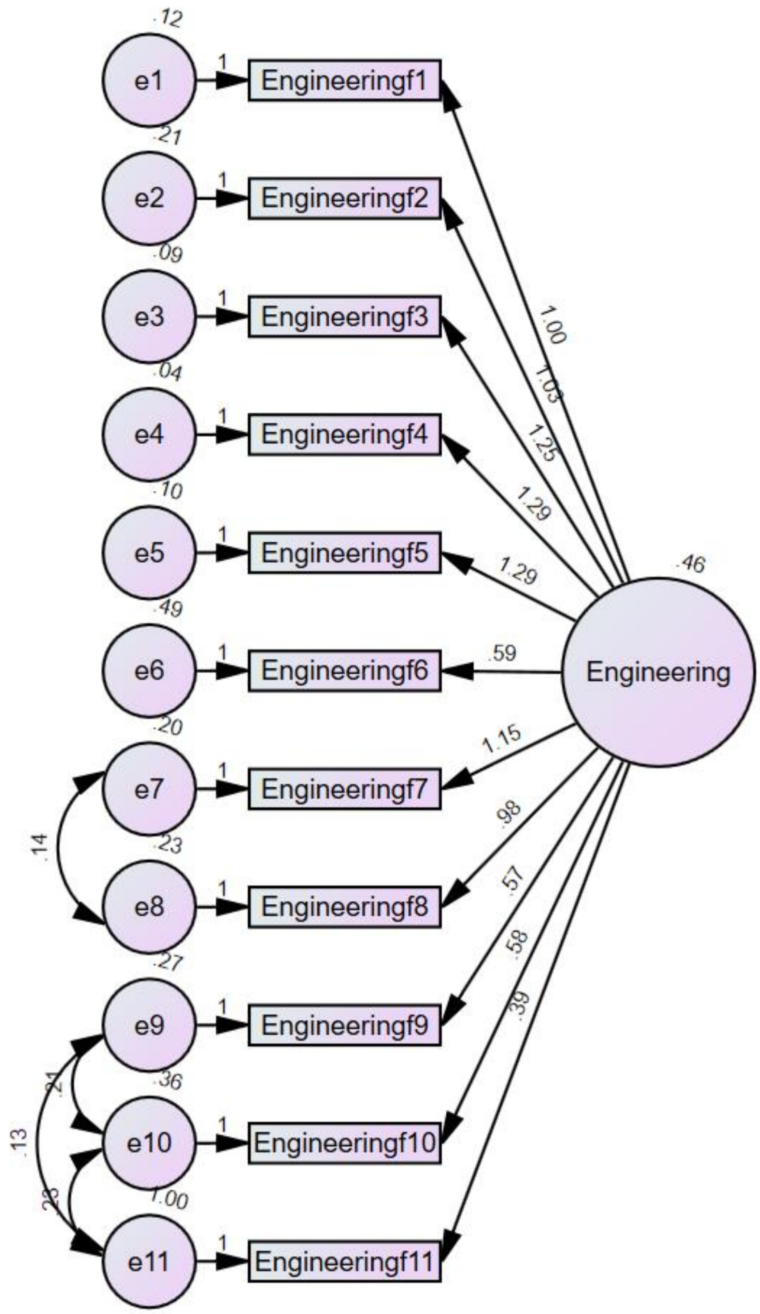

Fig. 12 Confirmatory factor analysis for Engineering

5.3.6 Result of One Factor Confirmatory Factor Analysis in Creativity

In Figure 13, the correlations between errors items e1 with e2, e1 with e3, e1 with e8, e2 with e3, e2 with e8 and e3 with e4 are linked with students' self-efficacy. The correlations between e3 with e11 and e10 with e11 account for that additional shared variance. These pair items share variance due to causes not accounted for by the alienation latent factors.

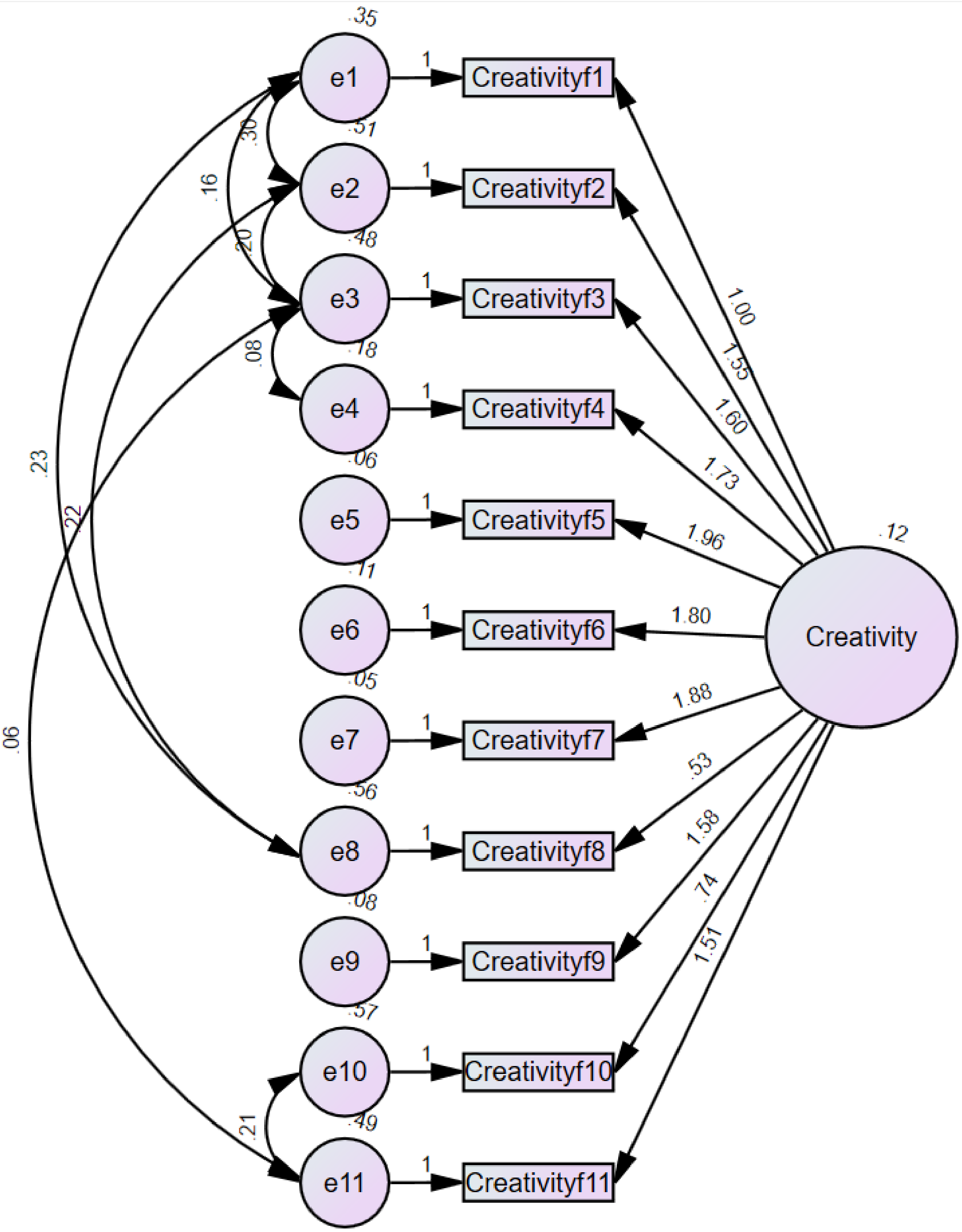

Fig. 13 Confirmatory factor analysis for Creativity

5.3.7 Result of One Factor Confirmatory Factor Analysis in Collaborative skills

In Figure 14, a correlation between errors items e8 with e9 both linked with students' personal input. The correlations between e6 with e7, e9 with e10 and e10 with e11 account for that additional shared variance. These pair items share variance due to causes not accounted for by the alienation latent factors.

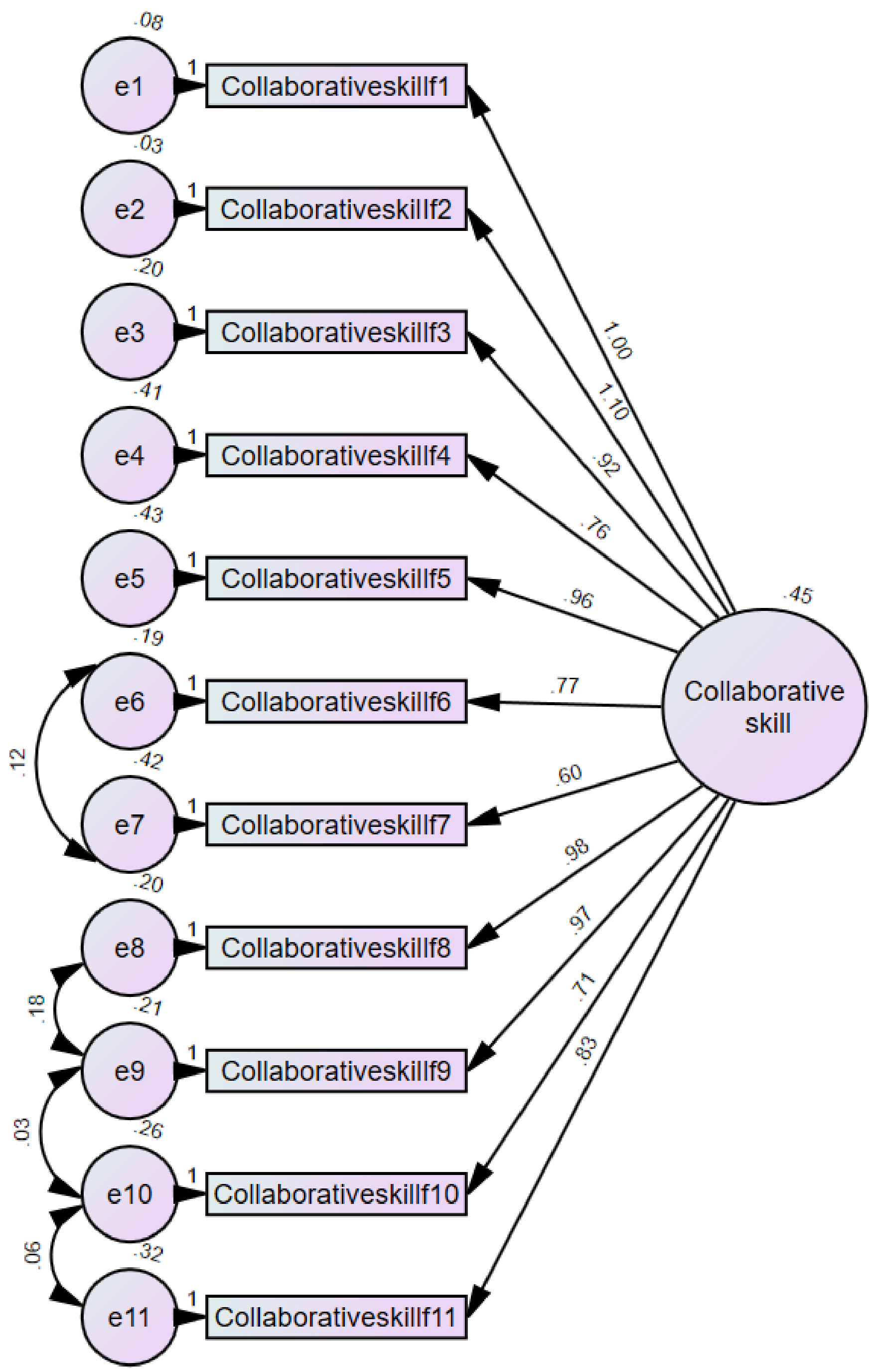

Fig. 14 Confirmatory factor analysis for Collaborative skill

5.3.8 Result of One Factor Confirmatory Factor Analysis in Problem-solving skills

In Figure 15, a correlation between errors items e1 with e2 both linked with students' self-efficacy. A correlation between error items e9 with e10 is talking about students' students' interest in problem-solving. The correlations between e5 with e6, e8 with e9, e9 with e11 and e10 with e11 account for that additional shared variance. These pair items share variance due to causes not accounted for by the alienation latent factors.

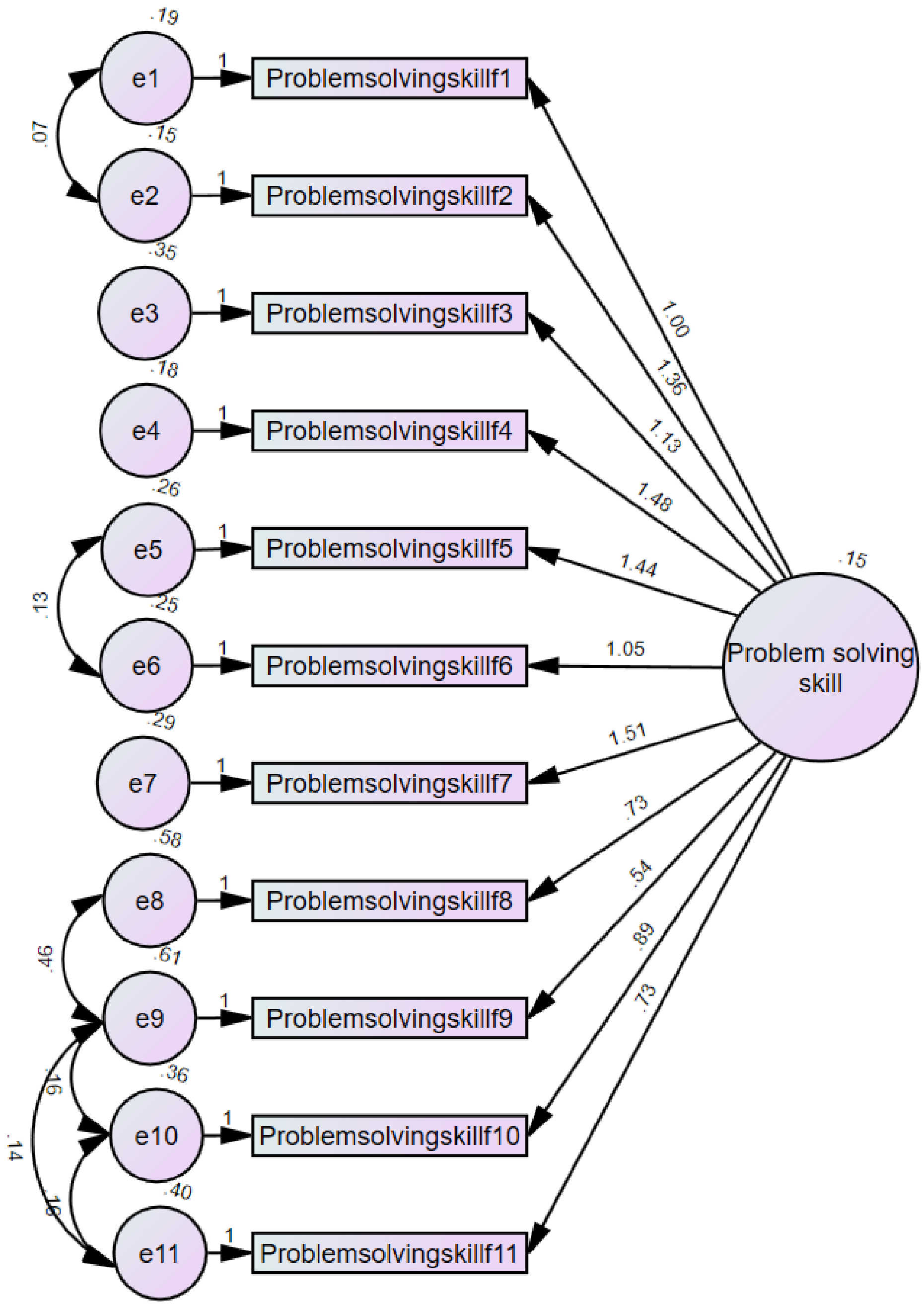

Fig. 15 Confirmatory factor analysis for Problem-solving skill

5.4 Interview

5 interviewees were randomly selected from the participants of the online survey. Each interview took 10 to 15 minutes to finish.

The interview first asked interviewees to share their experiences by giving examples of the STEM class, course, activity, and project they attend before. The STEM experiences included saltwater car competition, AI training courses, drone projects, coding courses, fly stick class (use static electricity to allow aluminum foil “fly”), robotic arm, and robot competition. These STEM experiences were usually related to technology and engineering aspects.

The second question asked about to what extends does the past STEM experiences affect participants’ choice on elective subjects of HKDSE and career intents. All of the interviewees said there was little or no effect of STEM experiences on their career intents. However, three interviewees said the past STEM experiences affected their selection of elective subjects of HKDSE to a medium to high extend.

The third and fourth questions asked about the advantages of STEM experiences on their academic performance and personal growth. All of the participants said that STEM experiences could only help them enrich their Other Learning Experience (OLE) to get into the university earlier as the university are more willing to admit students who are diversified developed. They also claimed that STEM experiences could not help them improve their scores unless they studied Information and Communication Technology (ICT). They claimed that the previous STEM experiences were more likely to inspire their interests in technology. In the personal growth aspect, none of the participants said the previous STEM experiences could improve the three main skill aspects (creativity, collaborative skill, and problem-solving skill). Only one or two skills were covered based on the assessment method. For example, if the project is teamwork, students thought their collaborative skill was improved. If the assignment asked students to create a product to solve a problem, they thought their creativity and problem-solving skill were improved.

The final question asked participants that if there any improvement was needed based on their past experiences. There three main aspects, they are course arrangement, course selection, and tutors' attitude. Three of the participants thought the past STEM experiences were not coherent and intensive enough. For example, they had an AI training course in the first two weeks and had a robot in the next two weeks. There was no relationship between the AI and robot courses. They were confused about using those technologies, and they could not keep studying interesting topics. One participant specially claimed that the attitude of the STEM course tutor was not professional. And some of the teachers only followed the teaching materials and directly taught the skill and let students follow his or her step, which could not excite students' interest in STEM.

6. Discussion

Through the Confirmatory factor analysis on the seven aspects of STEM education in Hong Kong with the social cognitive career theory, the result showed that self-efficacy, interest, personal input, and contextual support are the factors that most affecting student's career intents. Because there were always correlations between error items which both belong to the above SCCT aspects. For instance, except for mathematics and engineering, there were correlations between error items linked with students' self-efficacy in the CFA for science, technology, creativity, collaborative skill, and problem-solving skill. If students have high self-efficacy in an aspect, they are easier to succeed and feel successful in that domain. Students may want to keep these feelings and achievements to try to keep exploring that domain and choose to develop their career in that aspect. Personal input and contextual support and barriers are usually related to each other. There were always path-linked items of these two aspects in all CFA for the seven STEM components (Items e9, e10 and e11 in CFA) (Shek and Yu, 2014). Students are more willing to explore and make an effort on the aspects that they can get support from family, school, and society. Holmes, Gore, Smith, and Lloyd (2018) have done a research showing that students were more interested in and disposed to attempt the career aspects their relatives were working and familiar with.

There were always correlations between items that are talking about students' interest in different STEM aspects, personal input, and contextual support. The research showed the same result as students' self-efficacy, interest in specific aspects, personal input, and contextual support affect their career intents most (Lewko, Urajnik, Kauppi & Garg, 2010; Holmes, Gore, Smith& Lloyd, 2018). A point worth discussing, which was the residual variance of CFA for creativity and problem-solving skill, were much lower than the other STEM aspects. It meant the scale items could not reflect the actual situations to the factor. There was no clear cognition of students to these two aspects. Students might not recognize the STEM courses they attended had already covered and tried to improve their creativity and problem-solving skill. Therefore, more guides and instructions are needed for these two skills in future STEM education (Margot & Kettler, 2019). For example, teachers can set pre-test and post-test with clear statements to students for evaluating the improvement of the skill that EDB aims to achieve.

Combined with the interview result, a new point is concluded that STEM education affects students' options on the elective subject of HKDSE in a medium extends. About 70% of participants from the online survey and all interviewees had experienced STEM education for two or more than two years, which means they attended STEM courses when they were junior secondary students and had not chosen the elective subjects of HKDSE yet. After students attended STEM courses, they attempted some parts and knowledge of elective subjects and might further feel interested in them and then study them for HKDSE. This situation usually appeared in students who are not confirmed with their career intents. For students who already had explicit plans, the effects of STEM experiences are not that significant (Holmes, Gore, Smith & Lloyd, 2018).

Another notable result is STEM education affects students' career intents to small extents. Based on the interview result, all participants said STEM education affects their career intents in a small and even did not affect their career intents. The online survey result also shows that students tend to choose STEM-related careers because of the expectation from parents and society that STEM-related careers are the symbol of success and high income. Students did not change their career intents because STEM education was like an attempt and an after-school class. They were not intensive enough and could not allow students to be confident and ready to devote themselves to STEM-related careers.

The last point is that STEM education is not fulfilling all aspects of creativity, collaboration, and problem-solving. Only one or two of the above skills are covered simultaneously for each STEM course, which depends on the STEM course's teaching and assignment methods. For example, collaborative and problem-solving skills are covered when the assignment is a group work to solve or improve a specific topic like environmental conservation and the aging population. The interview result shows that the past STEM course was direct teaching in which students only follow the teacher's steps to finish the assignments, but without opportunity for them to get creative or create products on their own. The creativity aspects are usually ignored in STEM experiences.

7. Conclusion

This research investigates the relationship between students' experiencing STEM education and their career intents at Hong Kong senior secondary school. Through the conduction of social cognitive career theory-oriented online survey and individual interview, the findings show a significant result that STEM education affects students' career intents to a small extent but affects their selection on the elective subjects of HKDSE to a medium extent. Due to the incoherent and shallow STEM experiences, students might not change their career intents to STEM-related. They thought they were not able to acquire the knowledge and skills for STEM-related careers. Some improvements have to be made for STEM education in Hong Kong in course design and arrangement. Nevertheless, STEM education is still worth to be promoted as it allows students to access and excite their interest and curiosity of technology trends. (McClure et al., 2017) Hong Kong students must keep up with the international trends and prepare their knowledge and skills to be responsible citizens and contribute to society.

8. Implication

This research reflects some inadequate of recent STEM education in Hong Kong through the interview section. The current STEM course can be divided into two types, one is designed and taught by schoolteachers, and the other one is schools invite other education centers or organizations to teach. There is no regulation for STEM courses and led to incoherent and not intensive and reduces STEM courses' effectiveness. It is suggested a topic schedule for different STEM courses, such as coding courses followed by robot arm courses, followed by robot courses to allow students to learn the technology step by step so that the STEM experiences can be more coherent. EDB should encourage schools to develop their own student-oriented STEM courses based on the standard of their students instead of inviting other education centers to carry out teacher-oriented STEM courses. Sturm and Bogner (2008) claimed that student-oriented classes have much more advantages than teacher-oriented classes on students' learning motivation, engagement, and outcomes. And higher autonomy should be given to students that they can choose the interesting STEM course to study to improve their learning interest and the willingness to make efforts to have a better learning outcome (Margot & Kettler, 2019).

9. Limitation

There are myriad limitations to this research. The first and most observable limitation is the ratios of participants' gender, grade and school banding could not be controlled as the expected ratio was average for different aspects. However, there 70% of the participants were girl and about 50% of them were form 6 students from band 1 school. The resource of different banding schools is not the same so that the STEM experiences of other school banding students are different. This led to the deviation of the result, and the result trended to form 6 girls in band 1 schools. The collected data could not reflect the effects of STEM experience on overall Hong Kong students' career intents.

Another limitation is the sample size was small. The online survey only included 200 participants, and the interviews only had 5 interviewees due to the covid-19 pandemic. Less interaction between students led to the low distribution of the online survey, and face-to-face interviews could not be conducted. The interview could only be undertaken through ZOOM. The ideal sample size is more than 1000 as the higher sample size, the higher accuracy, and representative to the result. A more diverse and larger sample is required for a more representative and accurate result.

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11. Appendix

11.1 Questions of online survey

1.Date (generated by Google form automatically)

2.First name

3.Last name

4.Gender

Male/ Female

5. Please select your grade

S4/ S5/ S6

6. Please select your race.

Chinese/ Indonesian/ Filipino/ White/ Indian/ Pakistani/ Nepalese/ Japanese/ Thai/ Other Asian/ Others

7. Please select your school banding.

Band 1/ 2/ 3/ other

8.Please select the elective subjects that you have taken for HKDSE (any 1 to 4)

Chinese Literature/ Literature in English/ Chinese History/ History/ Geography/ Economics/ Business, Accounting and Financial Studies/ Ethics and Religious Studies/ Tourism and Hospitality Studies/ Biology/ Chemistry/ Physics/ Science: Combined Science/ Science: Integrated Science/ Information and Communication Technology/ Design and Applied Technology/ Technology and Living/ Physical Education/ Music/ Visual Arts/ Health Management and Social Care/ other:____________________(like Applied Learning Subjects)

9. Please write down the major or aspect that want to study at university or tertiary level and job after graduation. The following are the examples of majors,

Arts (Fine Arts, Music, Global Creative Industries)

Business and Economics (Finance, Economics, Marketing, Asset Management and Private Banking, Information Systems and Analytics)

Social Sciences (Counselling, Criminology, Geography, Media & Cultural Studies, Politics & Public Administration, Psychology, Social Policy and Social Development, Sociology)

Education (Early Childhood Education, Special Education, Chinese Language, English Language, Mathematics, Information and Communication Technology, Physical Education, Chinese History, Science)

STEM-related:

Engineering (Biomedical/ Environmental/ Energy/ Materials Engineering, Computer Science, Building Services Engineering, Civil and Environmental Engineering, Land Surveying and Geo-Informatics)

Science (Biochemistry, Biological Sciences, Ecology & Biodiversity, Environmental Science, Food & Nutritional Science, Mathematics, Physics, Statistics, Textiles and Clothing)

Health and Social Sciences (Health Technology and Informatics, Rehabilitation Sciences, Nursing, Optometry)

10. What is your level of understanding of STEM?

High/ Medium/ Low/ No

11.Do you have any experience in STEM education? For example, robot, coding, 3D printing, Design and applied technology, STEM project, STEM completion, STEM element design in the key learning area, Cross-Curricular Activities, STEM-related extracurricular activities.

Yes/ No

If yes, participants will be asked how many times of STEM class/ course/ activity/ project that they have taken.

once a week/ twice a week/ three times a week/ four times a week/ five times a week/ more than five times a week/ other: _________

12. How long have you experienced STEM class, course, activity or project?
Half-year/ one year/ more than two years

13. There are seven aspects related to career Interest after experiencing STEM education. Please select the most appropriate description:

Strongly Disagree (1), Disagree (2), Neither Agree nor Disagree (3), Agree (4), Strongly Agree (5) for the statements below.

Science

1. I can get a fine score in science-related subjects.
2. I can finish my science-related assessments.
3. I plan my future career will be science-related.
4. I make efforts in science-related subjects.
5. My future career can be enhanced if I do well in science-related subjects.
6. If I choose a science-related career, my parents will appreciate it.
7. I think careers that use science is interesting.
8. I like to study science-related subjects.
9. I have a model in science-related fields.
10. I feel comfortable when talking to people who are working in science-related fields.
11. There are relatives who use science in their careers.

Mathematics

1. I can get a fine score in mathematics.
2. I can finish my mathematics assessments.
3. I plan my future career related to mathematics.
4. I make efforts in mathematics class.
5. My future career can be enhanced if I do well in mathematics class.
6. If I choose a career related to mathematics, my parents will appreciate it.
7. I think careers that use mathematics is interesting.

8. I like to study mathematics.
9. I have a model in mathematics fields.
10. I feel comfortable when talking to people who are working in mathematics fields.
11. There are relatives who use mathematics in their careers.

Technology (include Information technologies, such as programmer, software designer, artificial intelligence specialist and digital consultant,
Building technologies, such as reclamation, design and construction,
Electrical and mechanical technology, such as gas fuel, air conditioning and refrigeration, lifts and escalators, plant machinery, water services and telecommunications
From: https://lifeplanning.edb.gov.hk/en/career/career-information/index.html)

1. I can do well in technology involved activities.
2. I can learn about new technologies.
3. I plan my future career will be related to technology.
4. I am interested in learning about new technology which helps me in school.
5. Learning about different technologies can help me develop in different types of careers.
6. If I choose a career related to technology, my parents will appreciate it.
7. I like using technology to finish my assignments.
8. I think careers that include a specific kind or different kinds of technology is interesting.
9. I have a model in technology fields.
10. I feel comfortable when talking to people who are working in the technology fields.
11. There are relatives who use technology in their careers.

Engineering

1. I can do well in engineering involved activities.
2. I can complete the engineering involved activities.
3. I plan my future career related to engineering.
4. I make efforts in engineering involved activities at school.
5. Learning about different engineering can help me develop in different types of careers.
6. If I choose a career related to engineering, my parents will appreciate it.
7. I like engineering involved activities.

8. I think careers that use engineering is interesting.
9. I have a model in the engineering fields.
10. I feel comfortable when talking to people who are working in the engineering fields.
11. There are relatives who use engineering in their careers.

Creativity

1. I am a creative person.
2. I always have unique ideas that others may not have.
3. I can apply new methods into solving problems creatively.
4. I can design new inventions to solve problems creatively.
5. I am able to build my model or creation solve problems in real life creatively.
6. I will test the model or creation continuously.
7. I can develop alternative methods to test the model or creation.
8. I can present my idea to others with clear and creative methods.
9. I can implement or integrate the model or creation in new context.
10. I think careers requiring creativity is interesting.
11. I plan my future career related to or required for creativity.

Collaborative skill

1. I like collaborating with others to complete tasks.
2. I like working with others to complete tasks.
3. I like sharing ideas with others to complete tasks.
4. I like listening to others' ideas to complete tasks.
5. I feel excited when group projects or assignments are assigned.
6. I make efforts in activities which required for collaborative skills at school.
7. I usually get high marks in activities which required for collaborative skill.
8. I feel comfortable when collaborating with others.
9. I feel comfortable when coordinating with others.
10. I think careers that required collaborative skill is interesting.
11. I plan my future career related to and required for collaborative skill.

Problem-solving skill

1. I am able to find problems.
2. I am able to identify the factors of problems.
3. I am able to suggest different methods to solve problems.
4. I am able to evaluate the most appropriate method to solve problems.
5. I am able to solve problems in a timely manner.
6. I feel successful after the problem was solved.
7. I feel comfortable when solving problems.
8. I am not afraid of facing challenges.
9. I like challenges.
10. I think careers requiring problem-solving skill is interesting.
11. I plan my future career related to and required for problem-solving skill.

14. Please leave your email address and phone number for further contact, thank you for your support.

11.2 Questions of interview

1. Please share some of the STEM activities and feelings you have had a deep impression on you in the past. Just one or two examples is fine.

2. To what extent has the STEM experience in the past few years affected your elective subjects for HKDSE or ambitions? Please explain why.

3. How much do you think STEM activities will help you with your studies and academic advancement? Please explain why.

4. How much do you think STEM activities have helped your personal growth (for example, creativity development, collaboration skills, and problem-solving skills)? Please explain why.

5. Do you think there is any improvement can be made from the past STEM experience? You can simply point it out.