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Article

The Development of Questionnaire to Measure Science, Technology, Engineering and Mathematics (STEM) Career Choice: Evidence from Cambodia

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Abstract

Internationally, there is a need for additional pupils to involve in science, technology, engineering, and mathematics (STEM) professions to expand the competitiveness and financial development of countries in this industrial revolution 4.0. Identifying the factors that affecting students' career choice will provide guidance for successful interventions as well as contribute to a well considerate of who want and who does not want to be involved in STEM. This will give sensible images to educators, institute career advice-givers and educationalists, concerning productive paths to restore the apparent failure of students' attention. Thus, this study aims to develop an instrument of factors affecting STEM career choice focus on female students for the context of Cambodia. The instrument development involved three stages process—literature review to support applicable items, generate a wide-ranging element group of items which will assessment the aim feature, primary trial assessment items, statistic reliability which check reliable of the questionnaire and exploratory factor analysis to control which items should eliminate from the group of items. In this study, the developed questionnaire was piloted with 195 grade 12th students from 4 different high schools in Cambodia. The analysis revealed that the Cronbach's alpha for each factory loading of survey revealed a great internal consistency. Items with factor loading below 0.400 were deleted from the survey questionnaire and some items were deleted to increase the Cronbach's alphas of survey questionnaire. Exploratory factor

analysis indicated that 110 items were grouped into four main factors, namely family factor, individual factor, school factor and environment and sociological. The newly developed toll will shed light on the assessment, and professional development to evaluate factors affecting STEM career choice within high school level pupils.

***Keywords**:* STEM career choice; Survey; Social cognitive career theory; Exploratory factor analysis

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1. Introduction

Science, technology, engineering, and mathematics have become to highlighted growth programs to boost economic and societal advancement of the state as specified in the Industrial Development Policy of Cambodia 2015-2025 (Ministry of Education, Youth and Shport (MoEYS), 2016). Promoting gender equality in STEM education is one of the STEM's policy strategies by encouraging female students to pursue their education and conduct research on STEM subjects and provide opportunities to women and men and institutions that work with education and research on STEM education.

More female adolescents are in institute nowadays than before, nevertheless they do not continually get equal chances like male adolescents in order to finish and get advantage from a training of their preference. Large number of females are vulnerable via favoritisms, public standards and prospects effect the value of schooling they obtain and the topics they train. They are principally less represented in STEM education, and therefore in STEM careers. Corresponding to the United Nations Educational, Scientific, and Cultural Organization (UNESCO) groundbreaking report "Cracking the code: Girls' and Women's education in STEM", only 35% of STEM schoolchildren in college and university level universally are females, and alterations are detected inside STEM areas. For instance, only 3% of girls in college and university level select information and communication technologies (ICT) subjects. This gender inequality is frightening, particularly as STEM professions are frequently suggested as the professions of the upcoming day, pushing improvement, public wellbeing, comprehensive development, and sustainable growth. Throughout the past periods, many schools and higher education curricula have been created with the specific purpose of helping

females in selecting majors focused on science. Regardless of these efforts, profession choice is still firmly based on gender stereotyped. It has been revealed females are played down in STEM research (Nagy et al., 2008), for instance, engineering is still noticed as a male-dominated area. In this study, researcher focused only on factors influencing female students' career choice with an academic of the last year of upper secondary school education (grade 12^{th}).

Internationally study has offered a great of understanding on career development and career choice. Factor influencing career development are comprehensive and recognized as being intrapersonal or contextual. These included outcomes on the significance of factors influence student career choice in context of developing countries with strong culture influence and big gap of gender equality as Cambodia. Those factors involve family, individual and psychological, school and society. Many studies about factors influencing students' career choices are conducted in developed countries; however, there is no previous study focusing on factors influencing students' career choice in Cambodia context. Kao & Shimizu (2019, 2020) studies on factors affecting students' choice of science and engineering majors in higher education and factors affecting Cambodian upper secondary school choice of science track. These two studies mainly focus on student major and subject choice, the studies didn't focus on students' career choice.

There are many existing instruments have been developed to measure factors influence student career choice. The studies focus on student interest: the factor which influence career choice of STEM (Bynum & Varpio, 2018; Creswell & Poth, 2016) and studies focus on peer influence with semi-structured questionnaire (Wang & Eccles, 2012; Eccles et al., 1997). However, those instruments do not included items about school variable based on Cambodian context and the current global situation. Thus, the primary purpose of this study was to develop a new instrument designed to measure the factor influence students career choice.

2. Literature review

2.1 STEM majors and its contribution to economic development

STEM is an acronym normally used to describe education or professional practice in the areas of science, technology, engineering, and mathematics. It is expected to build students 'conceptual knowledge of the inter-related nature of science and mathematics, in order to allow students to develop their understanding of engineering and technology (Hernandez et al., 2014). STEM majors include not only the common categories of mathematics, the natural

sciences, engineering, and computer/ information science, but also social/behavioral sciences such as psychology, economics, sociology, and political science (Kao, 2021).

As cited in Sarı et al., (2017): "The 21st Century is a technology age and STEM education plays an important role in influencing the culture and economic development with a viewpoint of innovativeness, creativity and problem-solving (Cooper & Heaverlo, 2013)." Intrinsically, numerous countries in the world have created important assets in STEM learning resourcefulness generally motivated by interests about possible shortages in STEM certified specialists in the future (McDonald, 2016; Langen & Dekkers, 2005). The upcoming success of various countries is based on long term involvement with STEM learning. In the following 5 to 10 years, 75% of the quickest developing professions will need STEM linked competences and experiences (Chubb, 2013). Universal concern in STEM has boosted considerably in latest times as an immediate outcome of the decreasing interest in STEM-linked professions and the estimated influence of this nowadays and into the upcoming (McDonald, 2016). Current international learning programs and transformations have concentrated on expanding the amount of leaners engage in STEM disciplines to guarantee learners are being ready and properly trained to participate in STEM professions (McDonald, 2016). According to Office of the Chief Scientist (2014), focusing on STEM fields has risen not only out of a perceived deficiency of trained laborers in new extremely high-tech subjects of professional, nevertheless also in relative to concern about STEM being educated as separate topics in institutes rather than as portion of a combined syllabus. Holmes et al., (2018) suggested while the gaps in STEM involvement are getting serious, therefore to a well considerate of who want and who does not want to be involved in STEM are going to give sensible images to educators, institute career advice-givers and educationalists, concerning productive paths to restore the apparent failure of students' attention.

2.2 STEM careers and the importance of STEM career choice

There is no standard definition of a STEM occupation. For the purposes of this Quick Take, STEM incorporates professional and technical support occupations in the areas of life and physical sciences, computer science and mathematics, and engineering (Noonan, 2017). The simple definition is that STEM careers are any positions in the field of science, technology, engineering, and math. It can be found across an array of sectors, from private businesses to big corporations, to nonprofits, to government jobs. It also requires knowledge of practice and processes that overlap the intersect the four disciplines. A person who has the career may be able to live a good and a fulfilling life. Such a person can raise a healthy family since with a good

career choice all may go well for such an individual. These and many things show how relevant a career is in the lives of all humans (Bossman, 2014). Indeed, career choice is as important as choosing a life partner since it is also a lifetime process. Just like becoming miserable when the wrong marriage partner is chosen, one can also become very unhappy of one's career so not well planned (Bedu–Addo, 2000).

According to Cambodia Development Research Institute (CDRI) (2015), Cambodia needs 35,000 engineers and 4,600 technicians to keep the nation gross domestic product (GDP) development of 6-8 percent over the next five years. The Royal Government of Cambodia has been paying close attention to these skills by strengthening and expanding STEM education service to serve national economic development and respond to career market demands as well as the Association of Southeast Asian Nations (ASEAN) integration. In order to help realize the Cambodia industrial Development policy 2015-2020, as indicated in the STEM education policy (2016), MoEYS also highlights that being a developing country and growing economy, Cambodian nation is in need of graduates in STEM fields. Therefore, to promote STEM education, MoEYS has published the Policy on STEM education because STEM are the forefront subjects and skills to realize Cambodia's long-term visions for 2030 and 2050 as specified in the Industrial Development Policy of Cambodia.

As cited in Holmes et al., (2018): "Decreasing registrations and involvement in STEM fields is an important matter for the reason that building capacity in the STEM fields is essential factor to preserving/growing output and universal competitiveness (Marginson, Tytler, Freeman & Robert, 2013, Office of the Chief Scientist., 2013)". This issue has been becoming more and more concerned at the period when society is becoming more depending on compound technologies. According to Office of the Chief Scientist (2014), focusing on STEM fields has risen not only out of a perceived deficiency of trained labors in new extremely high-tech field of professional, nevertheless also in relative to concern about STEM being educated as separate topics in schools rather than as part of an combined syllabus. Holmes et al., (2018) suggested while the gaps in STEM involvement are becoming serious, therefore a well understanding of who is and who is not interested in STEM will give sensible images for educators, institute career advice-givers and tertiary educationalists, concerning productive paths to restore the apparent failure of students' attention.

2.3 Extant tools to measure STEM career choice

There are many empirical studies focus on factors influence students' career choice in STEM fields in both developed and developing countries. Most of those studies using

quantitative approach with survey questionnaire cover many variables of factors affecting STEM students' career decision-making from one, two or all constructs of career development theories such as Bandura's Social Cognitive Theory (SCT), Social Cognitive Career Theory (SCCT), and so on. The studies focus on student interest: the factor which influence career choice of STEM (Bynum & Varpio, 2018; Creswell & Poth, 2016) and studies focus on peer influence with semi-structured questionnaire (Wang & Eccles, 2012; Eccles et al., 1997). But as current situation of world facing big challenge of Covid-19 pandemic, there is a new adaptation of learning was created. Therefore, those survey questionnaire of previous study are lacked some variables.

2.4 Theoretical and conceptual model on career choice

This study employed six theoretical foundations to understand students career choice: Occupational choice of E. Ginzberg, S. W. Ginsburg, S. Axelrad, J. L. Herma (1951); Super's Theory of Vocational Choice (1954); Holland's Career Typology (1959); Krumboltz's Social Learning Theory-SLT (1979), Bandura's Social Cognitive Theory-SCT (1986); Lent, Brown and Hackett's Social Cognitive Career Theory-SCCT (1987) and a model of women on construction management (Moore, 2006).

First, Ginzberg theory device into three stage of career development choice with four factors which influence students' career choice. The theory focuses on education, vision, values, goals, skill and interest. This theory does not fit with every adolescent because issue of gender, race and social class come into play to open or close door of occupational choice.

Second, Super's theory device into six stages focus on self-concept and experience. Self-concept changes and develops throughout people's lives as a result of experience. This research has omitted women, people of color and poor.

Third, Holland's theory presents the relationship of six personality and six occupational environments which mainly focus only on behavior. Individual attracted to a particular occupation that meets their personal needs and provide them satisfaction. There are gender bias in the theory because female tend to score in three personality type and attributes to our society that channels females into female-dominated occupational.

Fourth, Krumzbolt's theory device into four factors mainly focus on beliefs. People's belief: self-observation generalization, world-view generalization, task approach skills, and actions. This theory is useful for both individual and group.

Fifth, Bandura's theory devise into three main factors focus on motives, behaviors and experience. A person's output is based on a mixture of: 1 personal characteristics, 2 Behaviors and actions they see from other people. 3. Outside factors.

The last is Lent, Brown, Hackett's theory which know as Social Cognitive Career Theory (SCCT) emphasize four majors influence which focus on beliefs, self-efficacy, outcome expectation and personal goal. This theory is grown out of Bandura's social cognitive theory and attempts to address issues of culture, gender, genetic endowment, social context, and unexpected life events that may interact with and supersede the effects of career-related choices. The SCCT focuses on the connection of self-efficacy, outcome expectations and personal goals that influence an individual's career choice.

The career model focus on factors of non-traditional career choice refer to academic and career fields that are traditionally dominated by men. These occupations are characterized as male gender role specializations and positions that most women do not aspire to mor achieve (Winkelman, 1999). This model focus on family variable (gender role in family and parents influence), individual variables (ability, achievement, self-efficacy, and career interest), school variable (educational climate) and environmental and sociology variables (gender stereotype, role model and mentors, and counseling and advising).

2.5 Factors affecting students' choice of STEM careers: empirical evidence

Career choices comprise several domains and complex processes. The effect of family assistance and opinions on STEM have been developed from various circumstances, for instance, the progress of Social Cognitive Career Theory to integrate with social contextual factors (Lent et al., 2008). Workman (2015) confirmed that parent impact was a major between the subjects in the leaner choice-making process. Many researchers describe parents' gender labeling and promoted gender-typed profession decision-making affected self-perceptions of female students and their competences. It could be the reason for the less involvement of the girls and women in STEM as stated worldwide (Hartung et al., 2005; Tikly et al., 2018; Wang & Degol, 2017).

The second major factors are related to individual and psychological factor. According to Nugent et al., "Career interest is a predictor of both career preference and outcome" (Nugent et al., 2015). Researchers discovered career interest is constructively attached to the decision enroll in a discipline (Hulleman et al., 2008). School children who appear attention in STEM at the beginning in time frequently plan to learn STEM eventually (The Organization for Economic Co-operation and Development (OECD), 2005). In addition, SCCT theories explain the self-efficacy as a predictor of career interest (Fouad & Smith, 1996; Lent et al., 1994). The

character of individuality in profession choice making performance is well studied (Holland, 1959; Seibert & Kraimer, 2001; Sullivan & Hansen, 2004). Holland (1959) offered a concept indicating that an individual's career interest conveys their individuality. The concept indicated that individuality is a mixture of various factors comprising capabilities, interests, behaviors, and principles.

The third major factors are related to the experience in school. Numerous researchers examine the role of teachers and educators as crucial evidences in the procedure of adolescence's profession decision making (Yamashita et al., 1999; Howard et al., 2009; Cheung et al., 2013; Cheung & Arnold, 2014). Cheung et al. and Howard et al. reported "in both collectivist and individualistic cultures, teacher are seen as significant figures who are agents of development and could have influence on students' career decision making (Cheung et al., 2013; Howard et al., 2009). Cheung et al. also informed "pupils in Hong Kong evaluated understood effectiveness of instructors greater than parents based on lower education of their parents (Cheung et al., 2013). Additionally, Cheung and Arnold proved that pupil are firstly trust their teachers, secondly their colleagues and thirdly parents (Cheung & Arnold, 2014).

The fourth major factors are related to social and environment. According to Akosah-Twumasi et al (2018) mentioned the influence of community accountability as a major strength in adolescence profession choice was discovered by Fouad et al. (2016), who stated that the occupation choice of South Korean adolescence is affected by social beliefs. This is supported by another study, recommended that social beliefs affected adolescence profession decision-making in both collectivist and individualistic cultures (Mau, 2004; Tao et al., 2018).

Many factors influence female students' career in STEM were discovered by many studies in different contexts, but the shortfall of STEM participation has not yet been solved. Promoting gender equality in STEM education by motivating women for a many of theoretical and co-curricular can influence STEM field as career choice. This study reviewed the career development theories which fit with the context of Cambodia for the next study to investigate factors influence female students career choice in STEM. To promote female participating in STEM and choose STEM as their career for Cambodia context, detecting the issues influence interests in STEM will offer direction for productive involvements in addition to contribute to our understanding of in what way pupils study STEM content and how STEM profession courses are established.

2.6 Synthesis of theoretical and conceptual models and empirical evidence

Career choices comprise of several domains and complicate process. According to Gelatt's (1962) career choice model reveals the process of career choice as an on-going activity which changes by others source of fact. Outcome expectation is one the most important constructs that could inform about career choice. It assess adolescents belief of various professions based on their socio-economic situation and self-satisfaction outcomes (Abe & Chikoko, 2020). Another construct, career interest, is a prognosticator of in cooperation with career preference and outcome (Nuget et al., 2015). In addition of previous construct, self-efficacy was examined as a predictor of career interest as personal factor.

There are many existing career development theories such as Occupational choice of E. Ginzberg, S. W. Ginsburg, S. Axelrad, J. L. Herma (1951); Super's Theory of Vocational Choice (1954); Holland's Career Typology (1959); Krumboltz's Social Learning Theory-SLT (1979), Bandura's Social Cognitive Theory-SCT (1986); Lent, Brown and Hackett's Social Cognitive Career Theory-SCCT (1987). Beside Social cognitive career theory, most of the career development theory focusing on cognitive person variable and exclude extra personal variable from their theory.

Social Cognitive Career Theory (Lent et al., 1994) grown out of Bandura's SCT and attempts to emphasize cognitive-person variable that allow persons to impact their own profession progress along with extra-person (e.g., contextual) variables. Extra-person variable such as matters of culture, gender, inherited donation, public situation, and unpredicted life procedures that may cooperate with cognitive-person variable and outdo the influences of vocational-related selections, created to clarify and the behaviors in which persons formula vocation comforts, set goals, and continue in the labor atmosphere.

As numerous of career theories, many existing research tend to emphasis on persons who are intending to go to university, university students, or university graduated. However, gender bias, gender discrimination, exclude people from difference race and social class are found in many career development theories. Even though community influence is not hypothesized to be the most influential cause of self-efficacy, these affected messages to be expected effect a young female's self-efficacy concerning on her capability to do well in a science major. A well understanding of females' and males' greatest dominant causes of self-efficacy could be used to inspire females to choose less traditional majors.

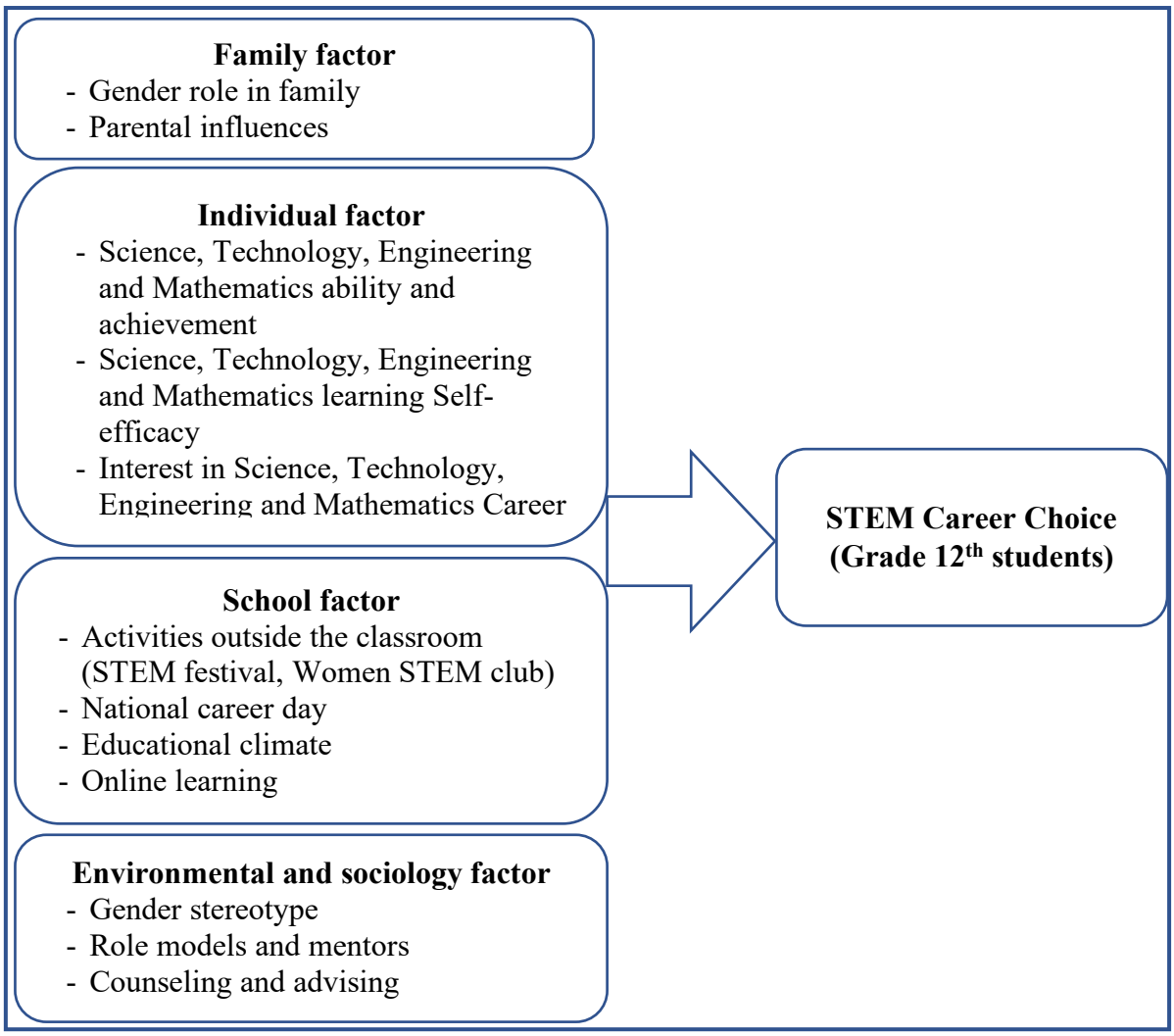
Moreover, investigating the alterations in other SCCT constructs (principally interests and outcome expectations) between males and non-females in science majors drive to improve the

understanding of vocational selections for pupils (Lent et al., 2000). The result from Kao and Shimizu (2019) revealed the most influential factors influencing pupils' selection of science and engineering majors in advanced schooling of Cambodia are the factors that deal with students' upper secondary schooling success in science and math and self-efficacy; their beliefs in enjoying the course in science and its practical nature, attitude towards science, parental occupation, sibling and relative's major, science and mathematics teachers at high school, and tracking system. Hartman & Hartman (2008) found that both male and female distinguish that male will face less barriers (with social care, value struggles, assurance, etc.) in science and engineering subjects than females. Kao (2013) also mentioned gender as factor affecting major selection. The number of girls enrolled in pure science and engineering majors in Cambodia is commonly lesser than the number of boys (Eam et al., 2019). As mentioned in previous sections, there are many factors influencing female career choice in STEM such as gender stereotypes, male-dominated cultures, fewer role models, math anxiety and so on. Different context might face different challenges, therefore, to reduce or close gender gap in STEM field we need to know the factors or barriers for Cambodia context and Secondary education is time allow students to choose their higher education (the education stage to prepare for career), we need to investigate the factors influencing secondary female students' career choice in Cambodia. Many studies about factor influencing female students' career choices conducted in developed country; however, there is no previous study focus on factors influencing female students' career choice in Cambodia context.

Cambodia has strong influence of culture and there is still a big gap gender equality. The study aims to use SCCT model but based on the Cambodia context. Therefore, this study will use the modified SCCT Model tested in study to test portion of SCCT, adopted theoretical framework from a theory of profession selection and development for female construction professionals by Moore (2006), and variables developed by researchers based on Cambodia context and current issue of education in STEM domain with a sample of grade 12th students in Cambodia.

Table 1

Synthesis of literature and SCCT



3. Methodology

The literature review contained of a search for research papers focusing factors affecting students' career choice in Science, Technology, Engineering and Mathematics, career development theories, non-traditional career choice and development, theoretical framework of career choice development. The search included using ERIC, Google Scholar, and searching using the terms *factor influence Career choice and development, instrument measuring factor affecting STEM career choice, Social cognitive career theory and STEM,* from the past 10 years. Specific subjects within STEM were also investigated to find literature involving *individual factor, family factor, school factor and social factor.* The result of searching previously described, finding suggested that there are many factors that influence STEM career choice like personal input, family and peer factor, school factor, environment factor, STEM

self-efficacy, perception of STEM career, and career interest which are described by Lent et al.'s social cognitive career theory. The literature review and theoretical framework showed the progress of our preliminary group of survey items, along with other tools determining a theory of career choice and development for female construction professionals (e.g., Moore 2006). The literature indicated the need for a survey instrument that was developed based on Cambodia's context and current issue of education in the STEM domain with a sample of high school students in Cambodia.

The progress of this survey created on former instruments (Besigomwe, 2019; Halim et al., 2018; Mtemeri, 2017; Kier et al., 2013), together with a modified social cognitive career theory model tested in study to test a portion of social cognitive career theory (Lent et al. 1994, 2000) and adopted a theoretical framework from a theory of career choice and development for female construction professionals (Moore, 2006), and variables developed by researcher based on Cambodia context as well as other developing countries and current issue of education in the STEM domain with a sample of high school students (grade 12th). The SCCT has been psychometrically assessed in expecting factors affecting career choice and currently has been employed to this new STEM career choice survey questionnaire.

Preliminary survey items were created that related to each of the characteristics of the social cognitive career theory. Researcher created a 110-item instrument with 5 statements per SCCT characteristic statements. Based on advice from science educators, researcher decided to use a 5-point Likert-type scale [responses including "strongly disagree" (1), "disagree" (2), "neutral" (3), "agree" (4), "strongly agree" (5)], therefore the items were connected properly to all the characteristics of the social cognitive career theory and that the survey questionnaires were understandable to upper secondary students.

Some construct and sub-construct were adopted from previous study and some are newly developed by researcher as shown in detail in the table below.

Table 2

Construct and Sub-construct of the questionnaire

Construct	**Adaptation**	**Subconstruct**	**Example of Items**
Family factors (15 Items)	Constructed by researcher	Gender role in family	My family members treat me the same as male siblings in the family

		Parents influences	My male guardian has influence in my choice of STEM as career
Individual factor (60 Items)	Adopted from Meredith W. Kier, et al., 2013; Halim. L, et al., 2018	STEM ability and achievement	I am able to get a good grade in my science class.
		STEM self-efficacy	I can obtain good grades in science subjects.
		Interest in STEM career	I plan to use science in my future career.
School factor (20 Items)	Constructed by researcher	Activities outside the classroom	I join STEM related clubs in school.
		National career day	I attend National Career Day.
		Educational climate	Generally, teacher treat male and female students the same.
		Online learning	I can do better in science and mathematics when I have online classes.
Environment and sociological factor (15 Items)	Adopted from *Jeofrey M.,2017 and* constructed by researcher	Gender stereotype	Male students have higher career ambitions than girls.
		Role models and mentors	I have a female professional as my role model.
		Counseling and advising	Advice from others influenced my career choice in STEM.

The pilot was employed to check the reliability of the newly developed survey questionnaire. The pilot questionnaire was conducted online with 205 grade 12th students from 4 different high schools in Battambang province and Phnom Penh city of Cambodia. The link of google form was provided to students to fill the survey. For all survey participants were

volunteer and they never see this survey questionnaire before. Among 205 responses, 15 responses were taken out from the study because of incomplete and duplicate.

Cronbach's Alpha will be used for checking reliability (internal consistency), and exploratory factor analysis will be used for data analysis. Acquiring the lowest number of explainable factors required to describe the correlations among the group of items by using exploratory factor analysis to investigate the dimensionality of an instrument (McCoach, Gable & Madura, 2013). The Cronbach alpha result of each sub-construct of the survey items shown in table below.

Table 3

Construct, sub-construct and Cronbach's alpha

Construct	Sub-construct	Cronbach's alpha
Family	Gender equality	.779
	Guardian influence on STEM	.860
Individual	Science ability and achievement	.808
	Technology ability and achievement	.749
	Engineering ability and achievement	.871
	Mathematics ability and achievement	.831
	Science learning self-efficacy	.869
	Technology learning self-efficacy	.816
	Engineering learning self-efficacy	.749
	Mathematics learning self-efficacy	.823
	Interest in Science career	.850
	Interest in Technology career	.836
	Interest in Engineering career	.879
	Interest in Mathematics career	.822
School	STEM related activities	.770
	Access to national career day	.863
	Teacher encouragement	.803
	Impact of online learning to STEM	.625
Environment and sociological	Gender stereotype	.662
	Female role model	.720
	Advice for STEM career choice	.783

4. Result

4.1 Content Validity: experts reviews

Content validity was used to examine the extent to which the items in the survey questionnaire are each aligned to four SCCT construct. First, the content of questionnaire was developed from literature review of existing theories and previous studies results. Therefore, this questionnaire content aligned with previous studies. Second, three researchers (two Cambodian and a Japanese) specialized in science education, physic education, and STEM review all the items in the survey. Since the questionnaire was developed in English, to check the translation into Khmer language, researcher has also had a Cambodian doctoral student at Hiroshima University to check for accuracy and completeness of the language. The last, factor analysis also employed in this study for checking the content validity which items loaded into one group based on the sub-construct of each factor.

4.2 Item reliability: factor analysis results

Exploratory factor analysis draws a huge set of variables and seeks for a way in which the data may be eliminate or shortened applying a reduced set of factors or elements. It does this by looking for bunches or clusters with the inter correlations of a group of variables (Pallant, 2011). In this study, exploratory factor analysis was used to examine the internal structure of set of 110 items and to validate the sub-constructs underlying for four main constructs i.e., family factor, individual factor, school factor, and environment and sociological factor. The construct in the study was developed based on SCCT theory, literature review on the factors affecting students' STEM career choice and content validity by experts in STEM fields. This study initially did not extend the analysis to the level of confirmatory factor analysis as the study only aimed to explore the sub-constructs underlying the identified construct-a process of developing an instrument. Based on statistical reliability and exploratory factor analysis, some items will be deleted because of low factor loading (<.400) and to increase reliability. The items with value of Cronbach alpha higher than .6 mean the item reliability is acceptable. A given statistical result in table 4, each construct and sub-construct have been displaying indicating a factory loading and Cronbach alpha. In family factor, originally there were 15 items, but 3 items were deleted because of factory loading is lower than .400 and to increase Cronbach alpha value of each sub-construct. Based on factory analysis, two sub-constructs were created and newly name as gender equality and guidance influence in STEM. 7 items out of 60 items were deleted because the same reason as family factor. Individual factor was divided into 12 sub-factors newly name as science ability and achievement, technology ability

and achievement, engineering ability and achievement, mathematics ability and achievement, science learning self-efficacy, technology learning self-efficacy, engineering learning self-efficacy, mathematics learning self-efficacy, interest in science career, interest in technology career, interest in engineering career, and interest in mathematics career. Among 20 items of school factor, 4 items were deleted as same reason from statistical analysis. 4 sub-factors were newly name as STEM related activities, access to national career day, teacher encouragement and impact of online learning to STEM. The last factor is environment and sociological factor, 4 among 15 items were deleted. 3 sub-factors were name as gender stereotype, female role model, and advice for STEM career choice.

Table 4

Factor Loading and Cronbach's alpha

1. Family factors: 12 items (15 items in total, 3 items deleted)

Statement	**Loading**	**Factor**	**α**
Q2.10.1 My family members treat me the same as male siblings in the family.	.789	*Gender equality*	.779
Q2.10.2 My relatives treat me the same as male siblings in the family.	.799		
Q2.10.3 I have an equal opportunity to go to school and choose a major I like as my male sibling.	.782		
Q2.10.4 I have an equal opportunity to choose my career as my male sibling.	.732		
Q2.11.1 My male guardian has influence in my choice of STEM as career	.697	*Guardian influence on STEM*	.860
Q2.11.2 My female guardian has influenced my choice of STEM as a career.	.746		
Q2.11.3 My male guardian encourages me to choose a career in STEM.	.765		
Q2.11.4 My female guardian encourages me to choose a career in STEM.	.738		
Q2.11.7 My male guardian's career had an impact on my choice of career in STEM.	.685		
Q2.11.8 My female guardian's career had an impact on my choice of career in STEM.	.664		
Q2.11.9 Information I got from my male guardian helped me to choose a career in STEM.	.678		
Q2.11.10 Information I got from my female guardian helped me to choose a career in STEM.	.709		

2. Individual factors: 51 items (60 items in total, 7 items deleted)

Statement	**Loading**	**Factor**	**α**
Q3.1a.3 I will work hard in my science class.	.764	*Science ability and achievement*	.808
Q3.1a.4 I like my science class.	.592		
Q3.1a.5 I take private class for science.	.834		
Q3.1b.1 I am able to do well in activities that involve technology.	.677	*Technology ability and achievement*	.749
Q3.1b.2 I am able to learn new technology.	.761		
Q3.1b.3 I will learn about new technologies that will help me with school.	.656		
Q3.1b.4 I like to use technology for class work.	.601		
Q3.1b.5 I am able to explain other about technology.	.623		
Q3.1c.1 I am able to do well in activities that involve engineering.	.796	*Engineering ability and achievement*	.871
Q3.1c.2 I am able to learn new engineering.	.785		
Q3.1c.3 I will learn about new engineering that will help me with school.	.717		
Q3.1c.4 I like to use engineering for class work.	.818		
Q3.1c.5 I am able to explain other about engineering.	.787		
Q3.1d.1 I am able get a good grade in my Mathematics class.	.843	*Mathematics ability and achievement*	.831
Q3.1d.2 I am able to complete my Mathematics homework.	.823		
Q3.1d.3 I will work hard in my Mathematics class.	.400		
Q3.1d.4 I like my mathematics class.	.616		
Q3.3a.2 I can solve problems related to science concepts well.	.441	*Science learning self-efficacy*	.869
Q3.3a.3 I can write laboratory reports (experimental reports) correctly.	.772		
Q3.3a.4 I can collect information on scientific concepts properly.	.712		
Q3.3a.5 I am sure that I can carry out scientific experiments in the laboratory properly.	.652		
Q3.3b.1 I can download an image or video from the internet.	.686	*Technology learning self-efficacy*	.816
Q3.3b.2 I can handle everyday technological products easily (e.g., blender, microwave, toaster, rice cooker).	.754		
Q3.3b.3 I can use the computer properly.	.466		
Q3.3b.4 I can handle digital devices properly (e.g., smartphone, iPad, tablet).	.806		
Q3.3b.5 I can use social media properly (Facebook, Instagram, Twitter).	.790		

Q3.3c.1 I am sure that I can build robot from Lego.	.518	*Engineering learning self-efficacy*	.749
Q3.3c.2 I can use welding tools properly.	.761		
Q3.3c.3 I can assemble furniture.	.730		
Q3.3c.4 I can build electronic circuits.	.706		
Q3.3c.5 I can repair a broken toy.	.698		
Q3.3d.1 I can obtain good grades in mathematics subjects.	.875	*Mathematics learning self-efficacy*	.832
Q3.3d.2 I am confident that I can record data accurately.	.575		
Q3.3d.3 I can draw a graph from the provided data.	.616		
Q3.3d.4 I am competent in using scientific calculators.	.520		
Q3.3d.5 I can solve mathematical problems properly.	.789		
Q3.4a.1 I plan to use science in my future career.	.714	*Interest in Science career*	.850
Q3.4a.2 If I do well in science classes, it will help me in my future career.	.637		
Q3.4a.3 I am interested in careers that use science.	.732		
Q3.4a.4 I would feel comfortable talking to people who work in science careers.	.734		
Q3.4b.1 I plan to use technology in my future career.	.690	*Interest in Technology career*	.836
Q3.4b.2 If I learn a lot about technology, I will be able to do lots of different types of careers.	.661		
Q3.4b.3 I am interested in careers that use technology.	.765		
Q3.4b.4 I would feel comfortable talking to people who work in technology careers.	.753		
Q3.4c.1 I plan to use engineering in my future career.	.769	*Interest in Engineering career*	.879
Q3.4c.2 If I learn a lot about engineering, I will be able to do lots of different types of careers.	.744		
Q3.4c.3 I am interested in careers that involve engineering.	.888		
Q3.4c.4 I would feel comfortable talking to people who are engineering.	.812		
Q3.4d.1 I plan to use mathematics in my future career.	.656	*Interest in Mathematics career*	.822
Q3.4d.2 If I do well in mathematics classes, it will help me in my future career.	.694		
Q3.4d.3 I am interested in careers that use mathematics.	.768		
Q3.4d.4 I would feel comfortable talking to people who work in mathematics careers.	.717		
Q3.4d.5 I know of someone in my family who used mathematics in their career.	.524		

3. School factors: 16 items (20 items in total, 4 items deleted)

Statement	**Loading**	**Factor**	**α**
Q4.1.1 I join STEM related clubs in school.	.663	*STEM related activities*	.770
Q4.1.2 I participate in a STEM festival.	.867		
Q4.1.3 I visit the STEM festival.	.807		
Q4.1.4 I participate in a STEM related competition.	.713		
Q4.1.5 I visit research centers at factories or at universities.	.567		
Q4.2.1 I attend National Career Day.	.781	*Access to national career day*	.863
Q4.2.2 I get a lot of information about my career on National career day.	.866		
Q4.2.3 I choose a career based on information I get from National career day.	.846		
Q4.2.4 National career day has influenced my career choice.	.796		
Q4.2.5 National career day is very useful.	.738		
Q4.3.1 Teacher actively encourage me to consider a wide range of career choices including those that are non-traditional.	.756	*Teacher encouragement*	.803
Q4.3.3 Generally, teacher treat male and female students the same.	.895		
Q4.3.4 Teacher expect the same achievement from females and males.	.885		
Q4.4.1 I can do better in science and mathematics when I have online classes.	.510	*Impact of online learning to STEM*	.625
Q4.4.2 I change my career choice from non-STEM related to STEM because of online classes.	.918		
Q4.4.3 I change my career choice from STEM to non-STEM related because of online classes.	.837		

4. Environment and sociological factors: 11 items (15 items in total, 4 items deleted**)**

Statement	**Loading**	**Factor**	**α**
Q5.1.2 Male students have higher career ambitions than girls.	.773	*Gender stereotype*	.662
Q5.1.4 Women's role is homemaker and male's role are breadwinner.	.722		
Q5.1.5 Boys can use computers more effectively to solve problems than girls.	.826		
Q5.2.2 Female models have influenced me to choose the career I want to do.	.698	*Female role model*	.720
Q5.2.4 I have a female professional as my role model.	.845		
Q5.2.5 I have a female mentor to guide me for career choice.	.861		
Q5.3.1 I get advice from my teacher to choose a career in STEM.	.747	*Advice for STEM career choice*	.783
Q5.3.2 I get advice from former students to choose a career in STEM.	.812		
Q5.3.3 I get advice from my classmates to choose a career in STEM.	.753		
Q5.3.4 Advice from others influenced my career choice in STEM.	.696		
Q5.3.5 I chose a career in STEM by myself.	.650		

5. Discussion

The purpose of this paper was to develop an instrument to measure the factor affecting upper secondary school STEM career choice focus on female students in Cambodia context. Science, technology, engineering, and mathematics have become to highlighted growth programs to boost economic and societal advancement of the state as specified in the Industrial Development Policy of Cambodia 2015-2025 (MoEYS, 2016). Identifying the factors that affecting students' career choice will provide guidance for successful interventions as well as contribute to a well considerate of who want and who does not want to be involved in STEM are going to give sensible images to educators, institute career advice-givers and

educationalists, concerning productive paths to restore the apparent failure of students' attention. The main four constructs (family, individual, school, environment and sociology) are developed from SCCT and added sub-construct (STEM related activities, Access to national career day, Impact of online learning to STEM) based on the current world situation and the new adaptation of learning processing in response of Covid-19 pandemic were used in this survey questionnaire. This study initially did not extend the analysis to the level of confirmatory factor analysis as the study only aimed to explore the sub-constructs underlying the identified construct-a process of developing an instrument.

Based on Moore (2006) study revealed that gender role in family was found to influence and/or support career choice despite varying family background demographics. Parent influence also has influence on students' aspirations for students to attend university (Lloyd et., al, 2018).

When the elementary and middle school students are engaged in discussions about goal and opportunities available in STEM, they have time to connect their interests to these subjects and demonstrate higher self-efficacy in these field prior to college (Skamp, 2007). Career interest is a predictor of both career preference and outcome (Nugent et al., 2015).

According to the COVID-19 pandemic, 2020, close to half the world's students are still impacted partially or full of school closures (UNESCO, 2021). Therefore, online learning was introduced worldwide and a sub-construct: Impact of online learning to STEM was added to this questionnaire in this condition. As the result, the factor's reliability scored the lowest among other since this were newly introduced. Interestingly, this could be a scenario of changing their career choice much easier from non-STEM related to STEM and vice versa. Cambodia STEM policy has been initiated since 2016, therefore, there are many activities were raised to promote this policy to be more interesting. At this stage, in the questionnaire, STEM related activities and Access to National career day factors were included accordingly. These should be the key to provide more information about students' interest in STEM in the context of developing countries or newly STEM introduced countries. For instance, according to the factor loading scores in STEM related activities, participating, and visiting STEM festival statements were well explained among others.

Gender has been an important point of many researchers investigate aspiration for STEM career choice (Eccles,1994; Packard & Nguyen, 2003; Shapka et al., 2006). Role models were found to be the greatest positive environmental influence on decision of women who work in construction management field (Moore, 2006). Most of the STEM related survey questionnaire were focus on STEM career interest (i.e. Kier et al., 2013; Tyler-wood et al., 2018), only few

were focus on STEM career choice. The survey questionnaire developed in this study is different from the existing surveys that measure the factor influence student STEM career choice represent an attempt to provide updated measures for factors influencing upper secondary students' STEM career choice in setting of developing country and strong culture influence with gender inequality as Cambodia. The instrument is easy to use and available online so that it is easy to implement in both formal and informal learning setting. This instrument includes new variable in school factor based on the current global situation of Covid-19 pandemic and based on Cambodian context.

The instrument used in the current study covered both interpersonal factor and intrapersonal factor which influenced career choice along with finding of Tzu-ling (2019), Yu & Jen (2019), Bennet and Phillips' (2010), and Jacobs et al. (2006). By understanding factors influencing students' career choice, STEM educators can help students in their career choice that reveal their values and experience.

6. Conclusion

The survey questionnaire was developed to measure the factors affecting students' STEM career choice intend to raise the consciousness of decreasing registrations and involvement in STEM disciplines, gender gap in STEM field. Based on exploratory factor analysis, two family sub factors were determined, namely gender role in family and parental influences. Additionally, four school sub factors were determined, namely STEM related activities, access to national career day, teacher encouragement and impact of online learning to STEM. The last, two environment and sociological sub factor were determined, namely female role model, and advice for STEM career choice. Other instruments have focus on segmented construct of career theories while the purpose of this instrument was to measure career choice in STEM focus on several factors.

We need to know the factors or barriers for Cambodia context and Secondary education is time allow students to choose their higher education (the education stage to prepare for career), we need to investigate the factors influencing secondary female students' career choice in Cambodia. This study details the result of the initial validation of a survey questionnaire that measure the portion of some construct in SCCT framework with extra-personal factors. A model is proposed here to measure some of these variables in SCCT construct.

7. Implications

The STEM career choice survey questionnaire developed in this study was shown to be psychometrically and equipped for further use by researchers or specialized developers in

Science, Technology, Engineering, and Mathematics, applying one factor or many factors or the entire themes within one instrument. Intrinsically, it is believed that this instrument will be help to other researchers, specialized developers, and inspectors in determining factors that influence students' career choice in developing countries' context. The understanding that researcher achieve from the usage of this instrument will support to notify at secondary school level in Cambodia as well as other developing countries as we seek to provide career counseling or advice for secondary school students. It is strongly expected that this survey questionnaire will contribute to researching the influence of our attempts to get attention from school children to know their requirements.

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