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Factor Affecting Female Students' choice of Science, Technology, Engineering, and Mathematics (STEM) Career Choice: Literature Review

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Abstract

Science, Technology, Engineering, and Mathematics (STEM) career serves national economic development and respond to job market demands for maintaining/ increasing productivity and international competitiveness in highly technological field of employment. Thus, this paper objectives to review previous research literatures about factors affecting female to participate in STEM careers and career development theories employed to promote female students' choice of STEM careers. Based on literature review, women are highly underrepresenting in STEM field as a world-wide phenomenon because of factors such as personal factor and extra-person factor. Among six career development theories, Social Cognitive Career Theory (SCCT) (Lent & Hackett, 1987) emphasize both cognitive-person variable and extra-person variable which different from others five career developments theories. Therefore, SCCT is good fit theory for the study conduct in Cambodia which has string culture influence for females. Implications for enhancing female students' participation in STEM careers were also discussed.

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INTRODUCTION

STEM defined as major emphasis in the world initiatives seeking to enhance economic prosperity via a highly educated workforce (McDonald, 2016; Office of the Chief Scientist, 2014; Riegle-Crumb et al., 2012). As cited in Sarı et al., (2017): "The 21st Century is a technology age, STEM education play an important role in influencing culture and economic development with a lookout of innovativeness, creativity and problem-solving (Cooper & Heaverlo, 2013)." As such, many countries in the world have made significant investments in STEM educational initiatives largely driven by concerns about potential shortfalls in STEM qualified professionals in the future (McDonald, 2016; van Langen & Dekkers, 2005).

The future prosperity of many countries is dependent on life-time engagement with STEM education. In the next 5 to 10 years, 75% of the fastest growing professions will require STEM related skills and experiences (Office of the Chief Scientist., 2013). Universal interest in STEM has significantly increased in current years as a straight outcome of the decreasing interest in STEM-related professions and the expected impact of this nowadays and into the upcoming. Recent universal educational initiatives and transformations have focused on growing the number of students pursuing STEM themes to guarantee pupils are well-prepared and properly trained to participate in STEM professions (McDonald, 2016).

The next parts of this paper will deliver a brief summary of the importance on STEM career choice, gender gap in STEM fields, key reasons for women to be involve in STEM, factor affect female such as barriers and challenges which females face in this field follow by the reasons that women need to be involved in the fields and to synthesis the most appropriate career development theory for research in female students' career choice among six career development theories.

METHOD

This review includes published research addressing the reasons why STEM career is important and how it contributes to economic development, gender gap and the berries that females face in STEM fields, benefits of female involving in STEM, synthesis of most appropriate career development theory for research in female students' career choice. To investigate this review, the researcher conducts this study is carried out database exploration articles (ERIC, Springer, google scholar and others search engine) that related to the female students, STEM careers choice and careers development theories. To confirm the appropriate articles were not unexploited, the researcher tracked the database exploration with a manual exploration in several journals such as Journal of Research in Science Teaching, Asian Journal of Education and Training, Science Education and International Journal of Science Education. Meanwhile there has been a deficiency of study on STEM education, this review published articles are in all four STEM disciplines which are science field, technology field, engineering field and mathematics field. Those articles were screened using key search terms such as "female career choice", "science and mathematics," "technology," "engineering," and "education". The mark off articles were chose based on the research in science field, technology field, engineering field, and mathematics field or the entire STEM education in a study.

The steps taken to investigate the factors affecting female students' of STEM career are: (1) identified the important of STEM career, (2) identified the gender gap and reasons for women to be involved in STEM, (3) factors affecting female in STEM choice and careers , (4) review the existing career development theories, (5) Finally, conclusion is presented in this review.

RESULT AND DISCUSSION

The importance of STEM career choice

According to Cambodia Development Research Institute (CDRI) (2015), Cambodia needs 35,000 engineers and 4,600 technicians to keep the nation state 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), Ministry of Education Youth and Sport (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 a 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.

Gender gap and key reasons for women to be involve in STEM

McKinsey Global Institute has recorded 15 gender equality indicators for 95 nations and initiate there were 40 out of 95 nations have high or very high level of gender discrimination on at least fifty percent of the indicators. The indicators are separated into four types: equality in professional life, important services and enablers of economic opportunity, legal protection and political power of speech, and physical security and sovereignty (McKinsey Global Institute & Woetzel, Jonathan; Madgavkar, Anu; Ellingrud, Kweilin; Labaye, Eric; Devillard, Sandrine; Kutcher, Eric; Manyika, James; Dobbs, Richard; Krishnan, 2015)the global economy will suffer. While all types of inequality have economic consequences, in our new McKinsey Global Institute (MGI.

The serve deficiency number of women is also felt across emerging economies, like Cambodia, where there are only 8.5% of female students in information and technology related for post-secondary level education. Additionally, the same barriers influence female in industries involved with technology all over the countries, further pressure, institutions and social limitations can stop young female from entering profession progressing occasions in the technology atmosphere in Cambodia (Tsang, Tiffany; Poum, 2018).

The deficiency number of females, both younger and older in STEM is a global remarkable case (Burke & Mattis, 2007; Ceci et al., 2009; Ceci & Williams, 2011; Cheryan et al., 2017; Stoet & Geary, 2018)Technology, Engineering and Mathematics is the definitive resource for anyone seeking to understand the numerous factors that impact diversity in STEM professions. Mary Mattis and Ronald Burke have organized the most meaningful statistics, research, and best practices into a comprehensive review of the challenges and opportunities to increase the participation of women in minorities in STEM. By making the complexity and pervasiveness of barriers to women and minorities apparent, Mattis and Burke help us recognize that we must implement solutions that encompass all stages in education, public images of the STEM professions and work place systems in industry and academia. Anyone who sincerely seeks to advance diversity in STEM will find this a priceless resource.' Christina M. Vogt, National Academy of Engineering. This fascinating work indicates that some developed countries face a looming shortage of skilled workers in science, technology, engineering and mathematics (STEM. Females are highly underrepresented in STEM field professions and are not represent of the total number of female employments. Therefore, females are mostly going to other area that are not related to STEM (Beede et al., 2011; Gilbreath, 2015).

To close gender gap in STEM, American Association of University Women (AAWU) suggests to provide both young and old females the skills with self-confidence to do well in mathematics and science subject, enhance STEM education and provision for young women starting in primary schooling and until K-12, encourage college women major in the STEM fields, professional attention, employ and retain females into STEM majors and fields in undergraduates and graduates level, expand occupation offering, maintain and advancement paths, and purposefully comprehensive beliefs.

Promoting gender equivalence in STEM education is one of MoEYS STEM education policy's goal to encourage female students to pursue their education and conduct research on STEM subjects because the number of female teachers as well as female students in STEM education are still low compare to the number of male teachers and male students (MoEYS, 2016).

Below are the key reasons that women

need to involve in STEM fields: For ASEAN integration, Cambodia has significantly established its human resources by exchanging information, skills, sciences, and technologies with other countries in ASEAN (Teacher, Law, November 2013). As the world trend swift from traditional to high-tech society, there will be jobs innovation in the future. Along with Sustainable Development Goals (SDG) number 5 (Gender Equality), World Health Organization (WHO) or the Organization for Economic Cooperation and Development (OECD) policy also promote female leadership. Most jobs in the future will be related in STEM and it will be also the highest paid too. As an example from Pew Research Center, a typical STEM professional makes around 65% more than those working in any professions not related with STEM. Females cover around 50% of the globe's population, in addition over 50 percent of Cambodia population. Studies reveals that growing the amount of females in STEM could equivalent to an extra $12 trillion in the worldwide GDP by 2025 (McKinsey Global Institute & Woetzel, Jonathan; Madgavkar, Anu; Ellingrud, Kweilin; Labaye, Eric; Devillard, Sandrine; Kutcher, Eric; Manyika, James; Dobbs, Richard; Krishnan, 2015)the global economy will suffer. While all types of inequality have economic consequences, in our new McKinsey Global Institute (MGI. Beside expand the world's economy, females also provide science a viewpoint that male couldn't provide. Therefore, more females in STEM can enhance the value of life and the security for both genders.

Factors affecting female in STEM choice and careers

Gender has been an important point of many researches investigate aspirations for STEM career choice (Eccles, 1994; Packard & Nguyen, 2003; Shapka et al., 2006; Hemandez-Martinez et al., 2008; Sadler et al., 2012; Watt et al., 2012; Novakovic & Fouad, 2013; Archer et al., 2014; Holmes et al., 2018)this paper asks what do young people aspire to at age 12/13, and what influences these aspirations? It outlines the main aspirations and sources of these aspirations as expressed by young people in England in the last year of primary school (survey of 9000+ Y6 pupils, aged 10/11, interviews with 92 children and 76 parents.

In order to decrease the gender imbalance in STEM field, consideration would be given to report the influential perceptive, motivation, and sociocultural factors, mainly by increasing the amount of profession choice that females perceive as achievable and well-matched with their skills, experience, favorites, and goal. Up till then, huge amounts of women who have talents in mathematics will remain to overcome the barriers when their decisions are limited by social barriers, gender discrimination and lack of information. So, the aim of this study to increase the professional choices for females by exploiting on cognitive strong point, highlighting hard work and support as an alternative of capacity, educating women attention in mathematics and science, and eliminating masculine stereotypes and lack of information that can threat profession choices (Wang & Degol, 2017).

Currently females are more encouraged than before by a diversity of academic and co-curricular inspirations to select STEM fields as a career. Still, the reports of the pupils' daily life make known imbalance, favoritisms, unfriendly campus cultures, instable identities, and an uncertain sense of belonging are still the obstacle for positive degree accomplishment and profession entrance. Beside these obstacles, female faculty similarly informs a collective insufficient of mentoring and caring policies (mainly for work-life stability) leading to tension (Blackburn, 2017). A part from the above barriers, a diversity of cause have subsidized to fail employment labors (Wang & Degol, 2017), including social factor (Cho et al., 2009; Lyon & Lyon, 2013; Thackeray, 2016), organized structures (Bottia et al., 2015)technology, engineering, and mathematics (STEM, bad quality of guidance (Lee, 2008) and primary schooling classroom atmospheres (Han, 2016). Nevertheless, researches reveal that developing an distinctiveness connected to STEM from an early age (Buschor et al., 2014; McCarthy & Berger, 2008), having caring relatives (Burge, 2013; Lyon, 2013; Lee, 2016), access to value recommending (Byars-Winston, 2014; Bystydzienski et al., 2015)funds, and initiatives aimed at expanding the nation's science, technology, engineering, and mathematics (STEM, experience with gender-inclusive video games (Bonner, 2015; Borghetti, 2014; Gilliam et al., 2017)we test the small molecule flexible ligand docking program Glide on a set of 19 non-α-helical peptides and systematically improve pose prediction accuracy by enhancing Glide sampling for flexible polypeptides. In addition, scoring of the poses was improved by post-processing with physics-based implicit solvent MM- GBSA calculations. Using the best RMSD among the top 10 scoring poses as a metric, the success rate (RMSD $\leq$ 2.0 Å for the interface backbone atoms, and could overall play a share in the choice to choose a profession

before enrolling in institution (Blackburn, 2017).

These encounters indicate a various and compound demonstration of factors, including gender biases (Hill et al., 2010), a deficiency of feminine role-models (Hill et al., 2010; Milgram, 2011), the set of courses and society of STEM instruction (Hill et al., 2010), and a belief of various STEM professions deficient common goal line or cooperative effort chances (Buhrman, 2006; Diekman et al., 2010)they remain underrepresented in the fields of science, technology, engineering, and mathematics (STEM. These factors cause many females to distinguish that STEM is 'not for them' and select other majors and profession tracks (Zachmann, 2018).

Career development theories

Career development theory is research focus on profession of pathways, achievement, and actions. Understanding career development theory is very important. Its purposes to clarify reasons for individual might be a suitable for a certain vocation and offer guidance on how to achieve a capable pathway. It likewise focusses on detecting mutual vocation phases at what time schooling, advices and other involvements are compulsory. Despite the fact there are variable privileges in dissimilar vocation progress concepts, all these concepts admit the status of educating a encouraging expressive connection through effort and of developed expressive specialized motivations.

This section will provide a summary overview of six career developments: 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).

Occupational Choice of E. Ginzberg, S. W. Ginsburg, S. Axelrad, J. L. Herma (1951)

This theory known as Progressive Theory, numerous of new and improve theories be wished-for many researchers. Nevertheless, the professional theory still assists as ground concept for vocation development. From this theory, Ginzberg described three conclusions: a. the development of vocational choice is restricted to teenage years and middle age phase; b. as a result of disaster and numerous of other ins and outs, individuals modification their career; c. afterward retirement, their career moves to others. Starting in preadolescent and finish in early middle age, persons go through three phases: fantasy, tentative, and realistic. This theory, there are six selections of oneself that effect occupational selections like varied living responsibility, trait and interest, cultural background, economic and social circumstances financial stability, and career guidance. But this theory doesn't suitable with all teenager's vocational selection procedure because it has been known the issue of gender, origin of individual and socioeconomic originate hooked on open or close accesses of professional selection.

Super's Theory of Vocational Choice (1953)

Donald Super created own development concept on the impression which a person views of him/herself changes. Period and knowledge benefit to shaped direction for individuals give value to their profession and the achievements they set. This concept defined vocation as the whole time of a individual which has six lifetime and vocation growth phases are (a) The crystallization stage ages 14-18, (b) Specification stage ages 18-21, (c) Implementation stage ages 21-24, (d) The stabilization stage ages 24-35, (e) Consolidation age 35, (f) Readiness for retirement age 55.

One of Super's extreme helps to vocation growth has been his importance of the role self-concept growth the stage. Super known the self-concept moves and grows through persons survives as a outcome of involvement. Persons consecutively improve their self-concept(s) actively and application to the global of effort produces adaptation in their occupation selection. While the vocation growth concept offers a basis for the specialized labor force its study has misplaced females, persons of race and the poor. Through the moving of labor force and nature of labor the concept has been so-called into question.

Holland's Career Typology – 1959

John Holland's theory is based on what he names modal individual orientation, or a progressive procedure created over inheritance and the person's life background of countering to environmental needs. Extra basically placed, persons pay attention to career that meets their individual desires and offers them fulfilment

Holland's concept based on four expectations are (a) In our principles, people can be characterized as one of the following: Accurate, Investigative, Imaginative, Societal, Enterprising or Unadventurous, (b) There are six type atmospheres: accurate, exploratory, creative, community, innovative and unadventurous, (c) Individuals hunt for surroundings that will allow them prac-

tice their experiences and capacities, deliver their insolences and principles, and take on agreeable difficulties and characters, (d) Actions is determined by an interface between character and situation.

A hexagonal model was established to explain the connection between individual characteristics and professional setting. A lot of study agrees with Holland's typology. The most influential condemnation is grounded on being male and female unfairness for the reason that female seem to be categorized in three-character types (imaginative, societal and unadventurous). Holland qualities to our community that channel women into women-dominated professional.

Krumboltz's Social Learning Theory - SLT (1979)

SLT tries to clarify the roots of occupation selection from the four main effects on how we choose an occupation such as genetic endowment and special abilities, task approach skills, environment conditions and events, instrumental and associative learning experiences. These four aspects cooperate with each other in composite and couldn't guess forms in each person and effect the perceptions we have of our self and the global. Based on to Krumboltz, the grouping of these 4 aspects product in accurate or inappropriate views, stereotypes and overviews about the person, occupations, working environment, civilization, and so on.

Individuals' views are: Own self-observation generalizations – noticeable and hidden explanations about individual capabilities, presentation and opinions, and follow-on generalized assumptions the person actions effect upcoming performance and intellectual – profession preparation. Global-view generalizations – noticeable and hidden explanations about the person's situation, illustration assumptions and results for how it's going to perform in the next day. Abilities to complete tasks – connections between inherent aspects, atmosphere aspects and education practices consequence in "cognitive and behavioral factors which represent the abilities, a individual takes to a conclusion of circumstances" (Krumboltz, 1979, p. 2), in this case occupation selection abilities. These maybe mark results or choices and so a person's occupation growth. Actions – learning practices sooner or later lead to occupation activities.

This concept is not just valuable for person preparation nonetheless Krumboltz applied in a cluster background through his investigation, enchanting the cluster over the diverse phases to discovery whether the concept functioned (Krumboltz, 1979, p.172). From the beginning of vision, it's hard to control how this connect to community education, till we realize that Krumboltz's philosophy is about simplifying and sponsoring knowledge. It's approximately inspiring persons to performance and not just to plot by identical themselves to a profession. Krumboltz distinguishes that the biosphere of professional is in endless change and the performance of societal learning is formulating customers for this ever-changing certainty. This begins to show the direction of "Planned Happenstance Learning Theory" which he established later.

Bandura's Social Cognitive Theory - SCT (1986)

Social cognitive theory, established by Albert Bandura, is the clue that a person's determinations and actions are grounded on skill. These skills can breakdown to three main groups: An individual is affected by self-efficacy, or what they trust they can reach. An individual is affected by how they perceive other persons accomplish and the activities they take. An individual is affected by features surrounding them that they cannot overtake.

In occupation progress, social cognitive theory benefits to clarify how an individual can set up their occupation progress proposal for achievement. Through a optimistic opinion of their own skills and around themselves with a optimistic network of guardians, an individual has a better chance of attaining their profession goals.

The framework for this concept is called "Bandura's Triadic Reciprocal Model of Casualty". This concept declares an individual's productivity is deepened on a combination of individual personalities; performances and activities, they perceive from other persons; and external influences.

Lent, Brown, and Hackett's Social Cognitive Career Theory - SCCT (1987)

The Social Cognition Career Theory (SCCT) has developed from Albert Bandura's social cognitive theory and tries to report problems of culture, being male and female, inherited donation, societal setting and unpredicted life events that may relate with and supersede the influences of vocational-related selections. The SCCT emphases on the linking of self-efficacy, outcome expectations and individual goals that effect a person's professional selection.

SCCT advises that occupation selection is affected by the perceptions, a person progresses, and improves through four main foundations: a) individual action goings-on, b) indirect knowled-

ge, c) societal persuading and d) biological conditions and responses. How these characteristics effort together in the vocation growth procedure is through a development in which a person progresses a proficiency/capability for specific effort and encounters with achievement. This procedure strengthens one's self-efficacy or perception in upcoming nonstop accomplishment in the practice of this proficiency/capability. As a outcome, one is likely to progress goals that include ongoing participation in that movement/effort. Through an evolutionary procedure start in premature age and ongoing through middle age, one constricts the possibility to positive actions to emphasis on and form a vocation achievement/selection. What is serious to the accomplishment of the development is the scope to which one opinion the effort/movement as one at which they are positive, and suggestions appreciated reward. The circumstantial influences come into play by affecting the person's belief of the possibility of accomplishment. If the individual distinguishes insufficient problems the possibility of accomplishment supports the occupation selection, but if the problems are seen as substantial there is a weaker interest and choice actions.

By teenage years, majority of individuals have a logic of their ability at a huge collection of action zones, accompanied by opinions about the possible results of a profession. Over a procedure of intervening education involvements that form supplementary one's skills and influences self-efficacy and outcome perceptions, one's professional comforts, selections and acts are formed and reformed.

The SCCT varies from common of existing career theories in its energetic original. Through its attention about the role of the self-system and the person's perceptions the intrinsic effect of the societal and financial settings is mentioned.

Synthesis of six Career Development Theories

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 researches 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 males 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 amount of girls enrolled in pure science and engineering majors in Cambodia is commonly lesser than the amount 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 stu-

dy focus on factors influencing female students' career choice in Cambodia context.

CONCLUSION

The literature review suggests that gender gap is still an issue in STEM field both education and career. 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 paper 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.

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