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STEM Interests and Future Career Perspectives of Junior High School Students: A Gender Study

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Abstract

Career choice and subject interests coincide as two significant factors for students to become driven in pursuing their academic and professional pathways. Though, literature studies revealed gender disparities in selecting educational tracks among students especially in the field of STEM. Hence, this study intended to analyze the gender differences in STEM interests and future career perspectives (FCP); and the relationships of FCP constructs, and of personal value and enjoyment. The participants were 334 junior high school students in the Philippines with 212 girls and 122 boys using non-random sampling. This study adapted the validated survey instruments from pertinent literatures to examine the variables. Based on the findings, there were no significant differences between and within the students' STEM interests and FCP in terms of gender. Both boys and girls have moderate interests in all STEM subjects except from trigonometry where boys have low interest. Additionally, there were weak positive correlations between and within the three FCP constructs. In contrast, a strong positive correlation was found between personal value and enjoyment. It is recommended that educational programs of schools should stimulate the STEM interests of junior high school students and improve their career guidance curricula.

Introduction

Career choice and subject interests coincide as two significant factors for students to become positively driven in pursuing their academic and professional pathways. Though, literature studies revealed gender disparities in selecting educational tracks among students especially in the field of STEM. Majority of the STEM population in different industries is dominated by male as this area of interest requires skills commonly observed from them. While other professions in STEM field constitute some females like health sciences, it is still evident that most of the practitioners hold a superior position showing that a small number of females are determined to lead the area of study. Females still continue to be underrepresented in the field of math around STEM even though the gender gap in math performance has lessened in recent years (Wang & Degol, 2017). Looking back at the experiences of STEM professionals while they were in high school, teachers' strategies on how they were taught and other contributary factors exhibited pieces of evidence to assert that it affected their interests to pursue STEM careers in the future.

Women under involvement in careers related to math and sciences have been an argument from different theories which proves that there is an irregularity when it comes to female representation across STEM fields. It is a need to address the issue in cultural stereotypes that discourage the women to pursue a STEM career because of the traditional domination by men (Zhang, Schmader & Forbes, 2009; Wegemer & Eccles, 2019). Su and Rounds (2015) supported that in the field of social sciences women are overrepresented, on the other hand, constituting only a small fraction in engineering workforce. Their study found patterns of gender differences in interests because of people-orientation and things-orientation of work environments which were not related with the required level of quantitative ability.

STEM Interests and Career Pathway among College Students

Morales, Avilla and Espinosa (2016) explored the gender inequality in K to 12 basic education and its influence in the interests to pursue a career in science or mathematics teaching. Factors including teacher-student interaction, teaching strategy, verbal teacher response and instructional materials encouraged the students to pursue a teaching career in science and mathematics despite the gender inequality that they experienced. Likewise, Cundiff, Vescio, Loken and Lo (2013) examined that gender stereotype in science was related with science identification and career aspirations among 1,700 undergraduate science students. The findings of this study showed that women have stronger gender stereotypes in science but weaker science identification and career aspirations while men have all stronger gender stereotypes, science identification and career aspirations.

Similarly, Morgan, Isaac and Sansone (2001) explained the gender differences in interest and career choice through college students' work and perceived goal affordances of physical/mathematical science careers. Greater interests for all careers were predicted by interpersonal goal affordances while interests for physical/mathematical sciences were predicted by high pay and status goal affordances which proved that interests to careers can positively predict the students' career choice. Kaleva, Pursiainen, Hakola, Rusanen and Muukkonen (2019) investigated the students' reasons for STEM choices and the relationship of mathematics choice to university admission because of high demand for STEM skills. The study showed that female dominated the university degree programs in Finland while male conquered the STEM fields with advanced mathematics as they were attracted by STEM careers. These studies presented that even at collegiate level, gender differences among STEM programs are extremely manifested that disclose opportunities to expand educational research concerning gender, career and STEM interests.

Factors Related to Career Plan

Fouad (1995) focused on promoting math and science career awareness through career linking as an intervention for high school students. The study's results specified success in high school choice and career knowledge while moderate success in self-esteem, achievement, and math and science course selection. Also, career pathways can motivate people to engage and employ mathematical ability for them to pursue a career relevant to STEM. While underrepresentation in math-intensive STEM fields among females in the US have been determined, the following factors including cognitive ability, relative cognitive strengths, occupational interests or preferences,

lifestyle values or work-family balance preferences, field-specific ability beliefs, and gender-related stereotypes and biases were generated from reviewing relevant articles (Wang & Degol, 2017).

Internal and external factors served as reasons for the gender gaps at all stages of the education system including the lack of females choosing STEM careers. These factors comprise of self-concept, influence of parents, media and educators. A study found out that early parental support increased the mathematics performance of males while no relationship when it comes to science achievement for both genders. Adolescents' STEM career interests maybe developed by social identities and self- concepts including the friendship groups, personal motivation, and gender (Ing, 2014; Robnett & Leaper, 2012).

Wang and Degol (2013) also studied the barriers and factors that influence the educational and career choices of individuals through literature review that center on sociocultural, contextual, biological, and psychological factors which result to gender differences in STEM interests and choices. Their study aimed to guide future research to design interventions that will improve individual capability and enthusiasms mostly for females who are interested to pursue STEM careers but are controlled by stereotypes. Moreover, Koul, Lerdpornkulrat and Chantara (2011) conducted a study about the relationship between career aspirations and motivations toward biology and physics, and the influence of gender among secondary school science-math academic stream students in Thailand. It explained that cultural beliefs about gender is important in career decision-making as there were gender differences in the motivating factors that influence career ambitions. Students' interests in science and math can be influenced positively depending on the strength of their academic motivation, abilities and capacity to succeed in those subject matters. Though the Engagement, Capacity, and Continuity (ECC) Trilogy, the sample students of their study possessed a high perceived personal capacity and interest in participating in engineering and technology activities with the fact that both female and male students would like to pursue engineering as a career brought by the stimulating activities (Weber, 2012).

STEM Interest and Career Perspectives

Kang, Hense, Scheersoi and Keinonen (2019) elaborated that gender differences in STEM fields and future career aspirations have connections and were part of a greater literature. Consequently, they examined the transient period to lower secondary school to determine how the degree of relationships between the factors of science interest and career perspectives differ between male and female students. Correspondingly, Sadler, Sonnert, Hazari and Tai (2012) conducted a retrospective cohort study to exemplify how the interests in STEM career of high school students change. Using the concept of gender differences in career plans, it revealed that males were more interested to pursue engineering programs while females were attracted to health and medicine areas which resulted to greater difficulty in encouraging female students to enter STEM careers.

Furthermore, Blotnicky, Franz-Odendaal, French and Joy (2018) studied the relationship between STEM career knowledge, mathematics self-efficacy, career interests, and career activities on the likelihood of pursuing a STEM career among middle school students in Atlantic Canada. Results showed that those students who have higher MSE and STEM career knowledge will probably prefer STEM future plans. Middle schooling can affect

the desire and ability to pursue STEM careers among students as they start to make choice during this time (Kang, Hense, Scheersoi & Keinonen, 2019; Sadler, Sonnert, Hazari & Tai, 2012). Hence, they should be provided with accurate knowledge about STEM careers to help them engage in different related courses of study. With the use of video interviews of STEM professionals as a method to inform students about STEM career possibilities, the study found no gender difference in STEM interest among the participants (Wyss, Heulskamp & Siebert, 2012).

Consequently, Direito, Connolly, Simon and Trevethan (2017) believed that it is very challenging to attract young students especially females to study and follow science careers. Though, school activities have the probability to be active in raising students' interest in science such as those that test expectations about gender stereotyped careers, that use images of scientists, and that endorse conversation on the rewards in working in science fields for both girls and boys. On the other hand, Christensen, Knezek and Tyler-Wood (2014) gathered the attitudinal data from 364 high school students to find out their perceptions of STEM content and careers. They found that residential students had STEM viewpoint more similar to STEM professionals which is less similar to traditional students.

There were significant gender differences in perceptions of science and scientists, out-of-school science experiences, science topics of interest, and characteristics of future jobs among males and females. A study revealed that there were significant gender differences in those aspects such that males had experiences and interests with tools, cars and technology while females preferred and had interests with bread-making, planting seeds, animal communication and weather. Additionally, females found science more difficult to understand than males who then found science as destructive and dangerous which means that their career aspirations for being a scientist can be predicted by their knowledge dispositions toward mathematics, science and engineering (Knezek, Christensen, Tyler-Wood & Gibson, 2015; Jones, Howe & Rua, 2000). Kurbanoğlu and Arslan (2015) investigated the difference between the 702 high school students' educational and career interest scores in terms of gender and grade level using two scales. They found out that there was no significant difference on the variables based on gender while there was a significant difference based on grade level. Meanwhile, Wang, Eccles and Kenny (2013) showed a pattern those females having math and verbal ability can have wider choice of careers including STEM and non-STEM fields as compared with males. The results from 1,490 12th grade students who participated in the study discovered that individuals, mostly females, with high mathematical capacity and high verbal skills were less likely to enter STEM careers than those with moderate verbal skills.

This study aimed to strengthen and expand the findings regarding the relationship of future career perspectives (FCP) and interests in mathematics and sciences among the students. In this regard, it intended to analyze the self-report responses on the two variables among junior high school students in the Philippines within the school year 2019-2020. Additionally, it supported the goal to examine the comparison between the male and female students' perspectives and interests in the context of gender stereotyping. In specific, this research sought to study the gender differences in future career perspectives (FCP); interests in STEM subjects; correlations between and within the FCP constructs; and between personal value and enjoyment.

Method

The research was participated by 334 junior high school students with 212 girls and 122 boys from different schools in the Philippines within the school year 2019-2020. This study utilized a descriptive correlational approach to measure the relationship between the STEM interests and future career perspectives of the participants based on their self-report responses suing the survey instruments adapted from pertinent literature. Additionally, using the descriptive quantitative design, the significant differences in variables between female and male students were analyzed through descriptive statistics (mean and standard deviation) then followed by t-test statistical analysis as guided by the p-value. The participants of this study were informed about the purpose of research during the conduct of data gathering. With the use of online platform, the survey was successfully directed where the participants have self-reported their responses according to their personal understanding of the items.

In order to measure the students' future career perspectives (FCP), a self-report instrument was adapted from pertinent literatures (Kang, Hense, Scheersoi & Keinonen, 2019; PRiSE scale; Harvard-Smithonian Center for Astrophysics, 2006; Oh, Jia, Lorentson & LaBanca, 2013), modified and validated by three experts in the fields of career counselling and STEM education to become suitable in the Philippine context. It consisted of nine questions divided into three career characteristics – outcome orientation, personal time orientation, and innovation orientation – related to career aspiration like 'What do you consider important for career satisfaction?' with four-point Likert scale (1. not at all important, 4. very important). In the same way, as supported by the person-object-theory of interest (Krapp, 2007, 2002), the mathematics and sciences interests of junior high school students were defined into three subcomponents of individual interest of learning STEM including personal value, enjoyment, and cognitive aspect. Survey items were related to the three subcomponents which were adapted from PISA students' questionnaire (OECD, 2007). Personal value consists of four items such as 'I will use science in many ways when I am an adult' while enjoyment in STEM consists of three items including 'I enjoy acquiring new knowledge in science'. Both of these subcomponents have four-point Likert scale with the response 1. strongly disagree to 4. strongly agree. Lastly, the students' cognitive aspect of STEM interest had a single question, 'How much interest do you have in learning about the following science topics?' – seven areas of STEM such as physics, chemistry, biology, earth and space, algebra, geometry, trigonometry, and statistics – which they answered using a four-point Likert scale 1. no interest to 4. high interest level.

Results

Based on the self-reports of the participants, the numerical values of their choices from the survey items based on the scale provided were tabulated and analyzed to meet the study's objectives. Table 1 presents the gender differences in students' FCP and STEM interests with all participants responded in all items. Using the range of 1-4 with corresponding descriptive interpretation, both boys and girls found the cognitive aspect as moderately interesting which is also the lowest rating among other variables. The students' future career perspectives – outcome, personal time, and innovation – were considered important for both boys and girls. Lastly, in personal

value and enjoyment as part of STEM interests scale, both boys and girls agreed with the items. In terms of the P-values, there were no significant differences between and within the students' STEM interests and FCP in terms of gender. This leads to the fact that both of them have the same viewpoints on these topics. The results lead to the analysis that both boys and girls aim to become successful in the future as a supervisor or leader who makes money having lots of time to bond with their friends and family members, and invent things.

Table 1. Gender Differences in Students' FCP and STEM Interests

Variable	Range	Girls (N=212)			Boys (N=122)			P-value
		Mean	SD	DI	Mean	SD	DI	
1. Outcome	1-4	2.92	0.94	I	2.90	0.96	I	0.83
2. Personal time	1-4	3.25	0.88	I	3.26	0.88	I	0.91
3. Innovation	1-4	3.19	0.88	I	3.12	0.94	I	0.35
4. Cognitive aspect	1-4	2.82	0.87	MI	2.80	0.91	MI	0.71
5. Personal value	1-4	3.31	0.66	A	3.19	0.78	A	0.08
6. Enjoyment	1-4	3.20	0.70	A	3.16	0.74	A	0.52

* The mean difference is significant at the 0.05 level.

Note. DI = Descriptive Interpretation, I = Important, MI = Moderate Interest, A = Agree

Table 2 shows the gender differences in students' interests in STEM subjects. Girls have moderate interests in all STEM topics in which according to increasing order, trigonometry had the lowest mean then followed by geometry, algebra, statistics, physics, chemistry, and biology while earth and space had the highest mean. Moreover, boys have the lowest interest in trigonometry while moderate interests in algebra, geometry, chemistry, statistics, physics, biology, and earth and space. Trigonometry was considered least while earth and space as most in terms of STEM subjects' interests among boys and girls. In summary, both boys and girls have moderate interests in all STEM subjects except from trigonometry where boys have low interest.

Table 2. Gender Differences in Students' Interest in STEM Subjects

Variable	Range	Girls (N=212)			Boys (N=122)			P-value
		Mean	SD	DI	Mean	SD	DI	
1. Physics	1-4	2.81	0.83	MI	2.88	0.82	MI	0.45
2. Chemistry	1-4	2.83	0.83	MI	2.74	0.84	MI	0.33
3. Biology	1-4	3.08	0.83	MI	2.89	0.87	MI	0.06
4. Earth and Space	1-4	3.23	0.83	MI	3.29	0.84	MI	0.56
5. Algebra	1-4	2.68	0.89	MI	2.66	0.96	MI	0.85
6. Geometry	1-4	2.66	0.86	MI	2.70	0.90	MI	0.68
7. Trigonometry	1-4	2.53	0.85	MI	2.44	0.92	LI	0.40
8. Statistics	1-4	2.78	0.85	MI	2.80	0.89	MI	0.90

* The mean difference is significant at the 0.05 level.

Note. DI = Descriptive Interpretation, MI = Moderate Interest, LI = Low Interest

In terms of the relationships between and within the three FCP constructs – outcome, personal time, and innovation, Table 3 shows that all variable items have positive correlations expect from OC1 and PT4 which is a negligible negative correlation. There were weak positive correlations between and within the three FCP constructs as grouped. The least positive correlations were found between OC1 and PT2, and OC2 and PT2 which are considered negligible while IV1 and IV had the most positive correlation which is considered very strong. The results satisfy the fact that the students relate the possibility to become well-known someday to having a secure job and develop new knowledge and skills.

Table 3. Correlation between and within Three FCP Constructs

Variable	OC1	OC2	OC3	**OC**	PT1	PT2	PT3	PT4	**PT**	IV1	IV2	**IV**
OC1	1.00											
OC2	0.26	1.00										
OC3	0.21	0.21	1.00									
OC	0.72	0.71	0.62	1.00								
PT1	0.09	0.10	0.23	0.20	1.00							
PT2	0.08	0.08	0.20	0.19	0.45	1.00						
PT3	0.19	0.10	0.37	0.31	0.33	0.27	1.00					
PT4	-0.01	0.10	0.21	0.14	0.22	0.21	0.21	1.00				
PT	0.10	0.12	0.35	**0.27**	0.72	0.65	0.57	0.69	1.00			
IV1	0.18	0.28	0.11	0.27	0.18	0.09	0.09	0.12	0.17	1.00		
IV2	0.19	0.24	0.29	0.33	0.31	0.31	0.32	0.10	0.33	0.36	1.00	
IV	0.20	0.31	0.23	**0.35**	0.29	0.21	0.24	0.15	**0.29**	0.89	0.72	1.00

* Spearman rho's (ranked) correlation interpretation (Prion & Haerling, 2014): 0.00 to 0.20 = Negligible, 0.21 to 0.40 = Weak, 0.41 to 0.60 = Moderate, 0.61 to 0.80 = Strong, 0.81 to 1.00 = Very Strong

Note. OC = Outcome, PT = Personal Time, IV = Innovation

Finally, Table 4 presents the relationship between personal value and enjoyment as part of the STEM interests constructs. In contrast to the future career perspectives, a strong positive correlation was found between personal value and enjoyment. The least correlation value was found between PV and EJ1 which is considered weak while the most positive correlation was found between EJ2 and EJ with a very strong interpretation. This means that the students had fun, interested with and enjoy learning math and science while at the same time believed that these subjects are relevant and useful in their lives as Filipinos.

Table 4. Correlation between Personal Value and Enjoyment

Variable	PV1	PV2	PV3	PV4	**PV**	EJ1	EJ2	EJ3	**EJ**
PV1	1.00								
PV2	0.57	1.00							
PV3	0.52	0.52	1.00						
PV4	0.50	0.46	0.55	1.00					
PV	0.80	0.79	0.79	0.78	1.00				

Variable	PV1	PV2	PV3	PV4	**PV**	EJ1	EJ2	EJ3	**EJ**
EJ1	0.39	0.45	0.52	0.35	0.51	1.00			
EJ2	0.44	0.54	0.51	0.43	0.58	0.62	1.00		
EJ3	0.50	0.55	0.59	0.50	0.64	0.54	0.66	1.00	
EJ	0.51	0.60	0.62	0.48	**0.67**	0.82	0.87	0.86	1.00

* Spearman rho's (ranked) correlation interpretation (Prion & Haerling, 2014): 0.00 to 0.20 = Negligible, 0.21 to 0.40 = Weak, 0.41 to 0.60 = Moderate, 0.61 to 0.80 = Strong, 0.81 to 1.00 = Very Strong

Note. PV = Personal Value, EJ = Enjoyment

Conclusion

This study pursued to investigate the gender differences in future career perspectives (FCP) and interests in STEM subjects; and relationships between and within the FCP constructs and between personal value and enjoyment among the junior high school students in the Philippines. Based on the statistical findings, there were no significant differences between and within the students' STEM interests and FCP in terms of gender. Both boys and girls have moderate interests in all STEM subjects except from trigonometry where boys have low interest. There were also weak positive correlations between and within the three FCP constructs. While a strong positive correlation was found between personal value and enjoyment. These findings suggest potential interventions targeting interests in STEM education to facilitate individuals' ability and career development and strategies to reform work environments to better retain girls' interests in STEM subjects and careers in the Philippines as a developing country in the world. In contrast to the literature review, Kang, Hense, Scheersoi and Keinonen (2019) found that there were clear gender differences concerning interest and preferences of science subjects and their relationship towards future career perspectives among lower secondary school students. Specifically, biology was preferred by females while physics and chemistry were preferred by males. Students can possibly enhance their interest in pursuing STEM careers once they are exposed to related activities and programs (Blotnicky, Franz-Odendaal, French & Joy, 2018). It is recommended that the development of educational activities should embrace the aim to stimulate the STEM interests of Filipino junior high school students like exposure programs where students can have the opportunity to interview some STEM experts in the country and abroad and study their working environment. Lastly, basic education institutions should improve the career guidance curricula especially for those students who will advance to senior high school program which identifies specializations including the STEM strand and in order for them to become equipped and prepared in higher education to study appropriate degree programs.

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