International Journal of Education & Social Sciences (IJESS)
ISSN: 2754-2793
Vol. 5 Issue 6, June - 2024

Curriculum Track and Major Selection in High School:

A Study of Female STEM University Students in Taiwan

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***Abstract*—This phenomenological study investigated the recollection of six female Taiwanese undergraduates in science, engineering, technology, and mathematics with regard to how they selected their major and curriculum track in high school. The participants were 19 to 25 years old. Participants who performed better in the humanities than in STEM still chose a STEM-related major in the 10th and 12th grades because of (1) job prospects, (2) influence from family, (3) a wish to challenge themselves in STEM, (4) a belief that STEM schools are better endowed than those in the humanities, and (5) influence from female role models in STEM.**

Keywords—curriculum track, major selection, female university student, STEM, high school

I. INTRODUCTION

Women are underrepresented in STEM (MOE, 2023). In Taiwan in 2023, only 20.45% and 28.69%, of undergraduates in the fields of engineering and computer science were women, respectively, and only 42.29% of undergraduates in natural science, mathematics, and statistics were women (MOE, 2023). In Taiwan, students must choose to focus on either STEM or the humanities in the 10th grade and must choose their university major in the 12th grade. Similarly, less than 50% of female students choose to focus on STEM. Thus, to address this underrepresentation of women in STEM, this study investigated the recollection of six female Taiwanese undergraduates in STEM with regard to how and why they came to focus on STEM in high school. In particular, the participants performed well in humanities subjects in high school but still chose to focus on STEM.

II. STUDENTS' SELECTION OF CURRICULUM TRACK AND MAJOR IN TAIWAN

A. Selecting a Template (Heading 2)

In general, high school students choose a specialization that they are good at and interested in (Deng, 1996; Hsieh, 2016; Liu, 2001). Most female STEM undergraduates have reported having an interest in and aptitude for STEM in school (Hsieh, 2016). Kuo and Sheu (2011) analyzed the influence of gender, math ability, and family characteristics on the choice of specialization among high school students. They found that specialization choice was most strongly determined by math grade, and also reported the underrepresentation of women in high school STEM tracks.

Lee (2017) reported that female students in a women-only high school, especially those with good math grades, were more likely to select a STEM specialization relative to female students in a co-ed high school. Chu and Rau (2000) explored the factors influencing students' career decision-making, and the results demonstrated individual interests, career information, decision-making strategies, values, social prestige as important factors influencing students' career decision-making. Chu (2019) identified that STEM extracurricular learning, self-efficacy, and occupational interest were associated with career selection by high school students; occupation interest was the most critical factor among these factors.

Chih et al. (2021) analyzed data on Taiwanese university entrance examinations from 1996 to 2010, and they also explored male students' and female students' preference for subject areas and the determinants of major selection. They reported that male and female students selected university majors mainly according to the gender attributes of the subject area. Although academic performance is an important factor influencing the choice of subject areas for both genders, family background and unobservable factors (e.g., sociocultural norms) also affect their major selection. They suggested that sociocultural normative factors have a long-lasting influence on students' choice of subject areas and their major selection. Kuo and Sheu (2011) analyzed the influence of gender, students' math ability, and family background on major selection by high school students, and mathematics achievement was identified as an important factor affecting students' major selection. Lin (2010) analyzed data from the Taiwan Higher Education Data Bank and reported three main factors of freshmen' s major choice: advice of significant persons, department rank and reputation, and career development.

Chen (2013) reported that 32% of Taiwanese 11th-grade students agreed with "boys are more suitable for enrolling into science programs than girls." The students' personal beliefs significantly affected their major selection. In that study, the results indicated that female high students who had a female math teacher as a role model were more likely to enroll into a science program. Sue (2003) investigated the relationship between the image of scientists and gender orientation among 11th-grade female students (half of them were studying in a science curriculum track, and the remaining half were studying in a humanities curriculum track); the researcher reported that female students who identified with a career in science and the humanities had a masculine and feminine self-image, respectively, that accorded with gendered social constructions of these disciplines.

Lee (2003) examined the influence of gender on curriculum track selection; they found that male high school students with higher scores in mechanical reasoning, spatial relationship, and abstract reasoning tended to specialize in STEM, and they observed that gender had no relationship with whether the students chose to focus on STEM. Liu (2001) investigated how and why women with a STEM bachelor degree changed careers, and "personal interest," "school and department ranking," and "test scores," "expectations of family members and parents," "influence of other people," and "impact of significant events" were the major reasons. Wang (1990) examined 407 female university students who selected nontraditional career paths, and the participants reported that their career choices were supported by their parents, friends, and siblings. Yang (2002) explored career themes among female undergraduates and found that the cultural context affected their career decision-making process. The participants described the following reasons for selecting to study in nontraditional fields: "learning something I like," "never worrying about money again," "wanting to improve my quality of life," and "being determined to never fall behind others."

III. How students across the globe choose their major

Enrollment, retention, and graduation rates among women in STEM are not good. The career choices of individuals of a given gender are influenced by social constructions of feminine versus masculine occupations and not just ability (e.g., Robnett, 2016; Watson et al., 2017). For example, the critical factors related to students' curriculum, subject, and major selection include significant others' expectations of the typical behavior of girls and boys, children's self-expectations, self-concept of their ability in the humanities versus technology/science (e.g., Trusz, 2018), and time spent on gender-stereotyped and gender-neutral activities (e.g., Hyde, 2014).

Chan and Cheung (2018) analyzed data from high school students in Hong Kong, and the results revealed that gender differences in subject perception (self-efficacy, interest, and perceived value), preference for job characteristics, and stereotypical beliefs in STEM were critical factors contributing factors to women's dropout from the STEM pipeline. Moreover, female students' positive perception of language and the humanities was negatively associated with their choice of STEM fields (Chan & Cheung).

Exposure to role models in STEM predicts higher engagement and interest in STEM, especially among women (Rosenthal et al., 2013). Chang and Cheung (2018) demonstrated that among women who are currently STEM students in Hong Kong, 63% of them have parents or elder siblings in STEM-related fields. Exposing girls to successful female role models (FRMs) can reduce negative stereotypes, because girls observe that people similar to them can succeed in STEM (Hill et al., 2010; Shin et al., 2016). FRMs in STEM imply to women that the female gender is adequately suited for STEM careers, and the presence of FRMs in STEM prevents the formation of negative stereotypes among women (Stout et al., 2011).

Rafanan et al. (2020) explored the perspectives of 20 senior high school students in the Philippines, and the participants reported that individual interest was the main reason why they chose to pursue a STEM education and career. He et al. (2019) investigated the potential reasons why female high school students in China were less likely to choose STEM subjects. Six female students from two Chinese high schools described the following factors in their decision-making for course selection: influence of the current science curriculum, teachers, job market, parents, and peers. Lv et al. (2022) surveyed 798 tenth-grade Chinese students, and the results indicated that female students' interest in STEM and STEM-related beliefs were positively related with their STEM career expectations. Women are more likely than men to have stronger preferences for liberal arts and to perceive their wide-ranging educational goals to conflict with the curricular requirements of certain STEM majors (Mann & DiPrete, 2013).

IV. Rationale of the study

A career model proposed by Swain (1984) that was modified by Jin (2023) was adopted as the reference framework of this study. Three major aspects of this model are as follows: (1) self-exploration; (2) university department exploration and job, occupation, and career information; and (3) evaluation of the influence of family and social factors on individual career decision-making. Individuals should explore and be aware of their abilities, interests, aptitude, needs, and values. To make career decisions, students should collect and comprehend information on university departments, occupation, and job market. Regarding environmental factors, family members, teachers, and peers influence students' major and career choices. Therefore, students should consider the aforementioned factors in the three aspects and the dynamics of these factors when selecting the curriculum track and university major.

V. METHODS

Phenomenological research entails a careful and comprehensive description of the ordinary conscious experiences of everyday life as well as a description of activities and the essential structures of consciousness as an individual or a group of individuals experiences them (Schwandt, 1997). This research method is consistent with the rationale of this study, which aimed to describe female undergraduates' recollection of how they selected their specialization in high school.

A. Participants

The study participants were six female students (Anne, Betty, Cindy, Debra, Elaine, and Flora) who were enrolled into three universities in Taiwan. The participants were pursuing different majors in STEM, and their average age was 21.45 years. A snowball method was adopted for recruiting participants. In-depth interviews were conducted for these students, in which they described their experiences of the selection of the curriculum track and university major when they were in the 10th grade and 12th grade, respectively. The inclusion criteria were enrollment into a STEM-related program; willingness to share experiences of the selection of the curriculum track and university major; and a greater interest and aptitude in the humanities than in STEM in high school.

B. Interviewer

A research assistant (RA) with a master's degree in counseling conducted interviews. Prior to the study, the RA completed courses in interviewing skills, counseling, qualitative research, and research methodology. The RA received training and completed pilot studies to refine her interviewing skills. She maintained an open and nonjudgmental manner and built trustful relationships with participants during the interviews.

C. Data Collection

The principal data for the study were obtained from six in-depth interviews, lasting 90–120 min. The RA contacted prospective participants to explain the purpose, procedures, potential risks, and benefits of this study. The participants signed the informed consent forms before the interview. They were asked the following questions in the interview: (1) "please describe your experiences of selecting the science curriculum track in the 10th grade;" (2) "please describe your experiences of selecting a STEM-related university major in the 12th grade;" (3) "please describe significant or notable ideas, thoughts, and perspectives regarding the aforementioned two choices;" and (4) "why did you choose to specialize in STEM despite your greater interest and aptitude in the humanities?" Finally, the recorded interviews were transcribed verbatim for data analysis.

D. Data Analysis

The first author served as the analyst. She analyzed data by following the procedures proposed by Moustakas (1994): (1) Reading through the written transcripts several times to obtain an overall feeling for them; (2) Identifying significant phrases or sentences that pertained directly to the experience; (3) Formulating meanings and clustering them into themes common to all of the participants' transcripts; (4) Integrating the results into an in-depth, exhaustive description of the phenomena; and (5) Validating the findings with the participants, and including participants' remarks in the final description. The analyst also employed strategies proposed by Gibbs (2007). She (1) checked the transcripts against the original recordings, (2) constantly compared the data with the codes and wrote memos about the codes and their definitions, and (3) cross-checked codes and compared results that were independently derived. In addition, strategies proposed by Creswell and Miller (2000) were adopted. The analyst (1) triangulated different data sources of information, (2) used member checking to determine the accuracy of the findings, (3) used rich description to convey the findings and provide detailed descriptions of the setting and multiple perspectives about a theme, (4) clarified the bias through self-reflection, and (5) spent prolonged time in the field to develop an in-depth understanding of the phenomenon and to convey details about the site and the people that lead credibility to the narrative account. The second and third author served as a peer de-briefer to review and ask questions to assist the analyst to reveal a more objective description.

VI. RESULTS

The participants recognized that they were more interested and had better grades in the humanities than in STEM; yet, they chose to specialize in STEM in the 10^{th} and 12^{th} grades. The factors contributing to their selection are as follows.

A. Job planning and career development

Some of the critical factors considered by the participants were job planning, employment, and potential salary. STEM jobs tend to be more prestigious, more in demand, and more generous in their compensation. Elaine stated that "I seriously think about my university major. As we all know, the technology industry offers more job opportunities and higher salary. Thus, a person with a STEM-related degree have better employment conditions and a better wage. Therefore, for my job planning, I choose to major in information engineering." The participants made a decision regarding the curriculum track and major based on job planning, job market, and career prospects.

B. Influence of family members

The participants expressed that they valued the advice from family members, such as parents, grandparents, siblings, and other relatives. The participants reported that many of their family members (parents in particular) were professionals working in STEM fields. They had been familiar with these family members' jobs since they were young. Their parents and other family members support the idea that women can learn and work in STEM, and this encouraged the participants to major in STEM. In addition, according to the participants' parents and elders, professionals in STEM tend to have high academic prestige, high social status, high salary, and favorable career development in the future. Betty stated, "[my] parents support me to select the science curriculum track and a

STEM-related major because of good social status, high academic prestige, and smooth career development in the future."

C. Intellectual challenge of learning STEM

The participants reported that it is easier to study humanities subjects than mathematics and science subjects, but they are willing to undertake the challenge of learning the difficult subjects of mathematics and science and to enhance their academic abilities. They are willing to work hard to overcome the barriers of learning mathematics and science. Flora described that "I feel [that it is] much easier to study humanities subjects than math or science subjects. I tell myself that I should not be defeated by math and science (curriculum), and I need to overcome it (difficulties in learning math and science). So, I take on the challenge and select the science curriculum track and major in natural science."

The participants believe that studying science will increase their knowledge base and provide a strong foundation for understanding the humanities. They believe that studying the natural sciences will help them build a foundation for understanding all types of knowledge and fields, including the humanities. Considering science to be the foundation of all inquiry, the participants had a strong motivation to broaden and deepen their knowledge on science, which facilitates their learning of the humanities. Cindy reported the following: "I know that having a strong foundation in science would assist me in acquiring increased competence for studying humanities, because I believe that science is a basis of knowledge and a foundation of all subjects. If I learn science well, I could conquer all."

D. Resources of science curriculum track and STEM programs

The participants were advised by teachers that science programs offer more abundant resources than humanities programs, especially on university campus. They were informed that STEM education programs are better endowed than those in the humanities due to a demand for STEM professionals. In this study, Anne noted that "my advisor told us (students) that students majoring in STEM would gain more resources at the university and have more job opportunities. According to my own observations, this is indeed the case." Therefore, the participants were motivated to enroll into the science curriculum track and to major in STEM.

E. Influence of FRMs

The participants mentioned that they were influenced by FRMs, including female teachers, mothers, relatives, and female siblings who are good at science and math. Debra said that "I [know] good female math and science teachers who teach math and science well. Some female family members also have master's degrees in mathematics and science. They encourage me to undertake the challenge of learning math and science and to be confident of my own abilities (in math and science). They are my role models who motivate me to learn math and science more and better."

In summary, the participants who were aware of their interests and abilities in the humanities selected the science curriculum track and enrolled into STEM programs because of better career prospects in STEM, the influence of parents and family members, the wish to challenge themselves in STEM to deepen their knowledge, the wealth of resources in STEM, and the influence of FRMs.

VII. Discussion

Gender disparities in STEM degrees continue to be a problem globally. Female students are more likely than male students to have stronger preferences for the humanities (including the social sciences). In this study, six female students who had greater interest and grades in humanities than in STEM subjects selected the science curriculum track in the 10th grade and a STEM major in the 12th grade. The study results do not echo previous findings that individual interest is one of the main reasons for students pursuing a STEM education (Chu & Rau, 2000; Lv et al., 2022; Rafanan et al., 2020), and students' math grade is the most important factor in curriculum track selection (Kuo & Sheu, 2011). The results do not support the existing literature that female students who selected STEM majors or careers tended to have personal interest and high academic performance in math and science subjects (Chan & Cheung, 2018; Deng, 1996; Hsieh, 2016; Liu, 2001). More importantly, the results do not support the gender stereotype that women are not suitable for learning and working in math and science fields (London et al., 2011) and boys are more suitable for enrolling into science programs than girls (Chen, 2013).

The results indicate that students' major selection is correlated with multiple factors. In addition to individual interest and academic ability, some factors are related to students' major selection. The results are consistent with the findings of Chih et al. (2021) that academic performance, family background, and some unobservable factors (e.g., sociocultural norms) influence students' major selection. In this study, despite participants having an interest and aptitude for the humanities, they were strongly determined to undertake the challenge of learning a difficult field (i.e., STEM), and they were motivated to enhance their scientific skills and acquire a firm knowledge base. The participants were driven by intrinsic motivation (i.e., the challenge of learning science to strengthen their knowledge) and external factors (i.e., job planning, career development, parental and familial factors, roles models, and resources of the environment). The participants majored in STEM for the career prospects.

In this study, the participants emphasized that FRMs motivated them to overcome the barriers of learning math and science and to break gender stereotypes. The results echoed previous results that FRMs, such as female math teachers, motivated the female students to learn science and related fields (Chan & Cheung, 2018). Exposure to FRMs in STEM predicts students' higher engagement and interest in STEM, especially among female students (Rosenthal et al., 2013). Female high school students who had a female math teacher as a role model were more likely to choose a STEM educational and career path (Chen, 2013). Women who selected nontraditional occupations reported the influence of social factors such as encouragement from teachers (Hsu, 2000).

The findings are consistent with ideas that major selection by female STEM bachelor holders are influenced by the expectations of family and parents (Liu, 2001); family background is a critical factor that influences high school students' choice of subject areas (Chih et al., 2021), female undergraduates make career choices that are supported by parents, friends, and siblings (e.g., Wang, 1990); family members are identified as the primary factor shaping high school students' STEM choice; and parents can be considered to be the most influential factor in high school students' decision to study or work in STEM fields (Chan & Cheung, 2018). When selecting their major, high school students are influenced by the expectations of significant others, career development (e.g., Lin, 2010), and their self-expectations (e.g., Rudman & Phelan, 2010; Trusz, 2018). The results of this study indicate the importance of family background (Kuo & Sheu, 2011) and parental and family influence on students' curriculum track and major selection in high school (e.g., Yang, 2002). The study results are consistent with previous findings that major selection is influenced by the "expectations of family and parents," and individuals gain "impact and support from other people," which affects their career choice (Liu, 2001; Wang, 1990).

The results correspond to the career model (Jin, 2023). The participants considered the factors of (1) self-exploration; (2) exploration of university departments and occupations, job market, and career information; and (3) evaluation of family and society factors for career decision-making. Regarding self-exploration, participants are aware of their personal interests and abilities in humanities. They, after thorough consideration, they tend to prioritize job planning, employment, salary, and career development. The results are thus partially consistent with previous findings why female students opted to major in nontraditional (e.g., STEM) fields, including "never worry about money again" (Wang, 1990), "to improve quality of life" (Yang, 2002), and recognition toward future career path (Hsu, 2000). In addition, female students consider the following factors when selecting their major and career, such as occupational interest (Chu, 2019), job market (He et al., 2019), career development (Lin, 2010), career information, values, and social prestige (Chu & Rau, 2000), sociocultural norms (Chih et al., 2021), school and department ranking, expectations of family and parents (Lin, 2010; Liu, 2001), family background (e.g., Kuo & Sheu, 2011), and influence of significant persons (e.g., FRMs) (Chen, 2013; Lin, 2010; Liu, 2001).

VIII. Conclusions and Implications

Multiple factors interact and affect students' selection of the curriculum track and university major. Female students consider not only interest and ability but also the challenge of learning science and math subjects. They gain support from female teachers, parents, peers, and significant others for overcoming the barriers in learning math and science. In addition, female students should collect a large amount of information on programs/departments, job market, academic resources, and career development before selecting the curriculum track and university major. Counseling and education professionals should assist students in thoroughly scrutinizing various factors to select a suitable curriculum track and university major; for such selection, students should consider not only their interests, abilities, and academic performance but also the influence and the support of parents and other family members, female teachers, and other role models as well as job planning, job market, career development, and sociocultural norms.

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