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Does "Women Friendliness" Matter in STEM Education?: Differential Effects of High-Impact Practices on Career Aspiration of STEM College Students by Gender

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ABSTRACT
This study examined the differential effects of High-Impact Practices(HIPs) on the career aspiration of STEM college students by gender. Through the theoretical lens of Social Cognitive Career Theory(SCCT), a two-level model analysis was conducted. A sample of 2,101 third- and fourth-year undergraduate students majoring in STEM at 38 universities, which had been collected from the National Survey on College Student Experiences and Learning Outcomes funded by the Korea Research Foundation, was used. This study found that the three HIP domains(learning with peers, faculty support, content relevancy) had different influences depending on gender. These findings suggest that HIPs can benefit the development of female students' career aspiration and have gender-differential effects on students in STEM majors. Based on those findings, this study also deduced implications about the roles of faculty members and higher-education institutions that might foster the retention of women in STEM.

Keywords: High impact practices, Female students, STEM majors, Career aspiration, Hierarchical linear model, Gender, College students, College effect

I. Introdocution

Women's attrition from the Science, Technology, Engineering, and Math(STEM) stream has received a great deal of attention around the world with respect to ongoing efforts to augment gender equality and, thereby, STEM's overall human-resource pool for national competitiveness (Faber et al., 2009; MEST, 2011). The national government in South Korea also has enacted policies attempting to reinforce systematic efforts to retain more women in the STEM stream(e.g. Basic Plan for Fostering and Supporting of Women Scientists and Engineers). A paradigm that such policies aim to instill at schools and workplaces is "women-friendliness," underlying incorporation of women's perspectives into practices(Faber et al., 2009; Lee & Lee, 2006). In fact, these policies significantly highlight the role of higher education in catering to the perspectives of female students in their learning experiences, with the expectation that the intended changes will encourage them to aspire to STEM jobs and transit into related workforces(Kitchen et al., 2018; Oh, 2007).

The notion of imparting women-friendliness to learning experiences has its basis in academic studies that claim a particular type and process of women's development in college(Espinoza, 2011;. Gwag, 2008). Expanding on the "ethics of care" by Gilligan(1982), Belenky et al.(1986), for example, posited "Women's ways of knowing." The essential consensus of their studies is that the relational component is more important to developing various types of college outcomes of female students than those of male students in student's development and learning.

However, traditional educational practices in STEM majors have been mostly void of understanding of, nor have they incorporated, such characteristics of women's development (Astin & Astin, 1992; Espinoza, 2011; Hall & Sandler, 1982; Min, 2003). These practices have been attributed to female students' negative learning experiences in STEM

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majors(Astin & Astin, 1992; Espinoza, 2011; Min, 2003; Rosser, 1990; Sandler et al., 1996). Subsequently, the negative learning experiences have been identified as a significant reason for female students' diminished self-efficacy and career aspiration. Often the degree of such decrement for female students is greater than for male students in STEM majors(Do, 2009; Min, 2003).

High-Impact Practices(HIPs), in fact, have received attention as a set of educational practices that can effectively improve the learning experiences of female students in STEM majors and, thus, decrease their attrition from the STEM stream. This is owed to the fact that the elements of HIPs fundamentally encourage students to get involved in their learning and to maximize their development, regardless of their background(Astin & Astin, 1992; Chickering & Gamson, 1987; Kuh et al., 2011). Furthermore, HIPs in its essence facilitate the systematical interactions of all students as well as the chances for students to contextualize theories and reality while learning, of which factors are essential in women's learning. Various studies have revealed the positive impact of HIPs on female student's college outcomes such as cognitive outcomes(Cabrera et al., 2002) and persistence (Espinoza, 2011; Soldner, 2012).

However, there has been a lack of scholarly work that comprehensively examines whether HIPs can be more effective for female students' career development outcomes(Cabrera et al., 2002; Espinoza, 2011; Sax, 2008). In particular, career aspiration predicts and influence students' future success in their career preparation and development(Gray & O'Brien, 2007; Kim et al., 2016). Considering the urgency of fostering more female students to continue their pathways to career development in STEM fields, career aspiration is one of the meaningful educational outcomes to be examined in relation to the HIPs.

A few currently available studies provide a glimpse of the gender-differential effectiveness of HIPs on the career-related development of students majoring in STEM. For example, collaborative teaching practices and peer interactions have been found to have stronger effects on female students' intention to persist in STEM majors and careers than on that of male students(Colbeck et al., 2001; Watkins & Mazur, 2013). Faculty-student interaction, though, has shown mixed effects: stronger on female students' intention to pursue careers in STEM fields but negative on persistence(Byoun, 2016b; Eagan et al., 2013). Regardless, these studies are still limited to examining HIPs fragmentarily; they do not analyze comprehensively the effects of all HIPs' elements on the career aspiration of female students in STEM majors.

The present study aimed to comparatively investigate the effects of HIPs on students' career aspiration based on gender by applying Social Cognitive Career Theory(SCCT). In addition, the study expanded SCCT by considering the effects of institutional factors, because universities' different characteristics can generate different environments that shape educational practices(Choi & Rhee, 2013; Franke & DeAngelo, 2013). The main research questions were as follows:

(1) Does a gender gap in the career aspiration of students majoring in STEM exist?

(2) Do HIPs have gender-differential effects on the career aspiration of students in STEM majors?

II. Literature Review

1. Women's ways of knowing

It was feminist scholars who first shed light on gender differences in the nature and process of intellectual development(Espinoza, 2009; Min, 2003; Oh, 2007; Sax, 2008). For instance, Gilligan(1982) castigated the conventional theory of student intellectual development for its lack of understanding of gender differences. She claimed that the conventional theory proposed that youth of both genders develop their intellectual ability by achieving autonomy, separation, and individuation. However, the factors that facilitate women's intellectual development were found to be rather understanding, sense of attachment, responsibility, and care(Gilligan, 1982 as cited in Sax, 2008). Extending Gilligan's work, Belenky et al.(1986) established a foundational theory on women's ways of knowing. By interviewing 135 women from rural and urban areas in the U.S., they concluded that "connection over separation, understanding and acceptance over assessment, and collaboration over debate"(p.229) are crucial in order for women to reach the highest stage of learning.

Table 1 Elements that improve women's learning

Researcher(s) (year)	Elements
Belenky et al. (1986); (1996)	• Relations (relating one's own experience to study materials) • Discussions and dialogue • Collaboration to construct knowledge • Teachers' support and recognition of female students as possessing unique ways of knowing
Maher & Tetrault (1996)	• Positional approach (relating the study material to one's context) • Building knowledge by sharing perspectives from students of both genders
Rosser (1990)	• Decreasing competition in the classroom • Increasing a sense of community in the classroom • Discussing how the role of scientists is related to students' lives • Presenting scientific discoveries using appropriate social context
Baxter Magolda (1992)	• Learning as a relational activity: learning knowledge by understanding related contexts • Interpersonal interactions, collaborations, and consensus
Shapiro & Sax (2011)	• Connecting theory to real-life problems and social contexts • Increasing classroom interactions with peers and faculty • Reducing the stereotyping of STEM as a masculine field • Peer role models and sense of community

The essence of Gilligan and Belenky et al.'s findings is the relational nature of women's learning. In other words, women's learning can be maximized when they are allowed to make connections and form relationships with peers, teachers, and learning materials(Belenky et al., 1986; Maher & Tetreault, 1996, Gwag, 2008). In particular, later research by Belenky(1996) found that dialogue and discussion with peers had a strong impact on women's learning. Baxter Magolda(1992) also claimed that interpersonal interactions, collaborations, and consensus play a larger role in women's intellectual development than in men's, while relational aspects also matter to men(cited in Sax, 2008). In addition, Belenky et al.(1986) emphasized the role of the “connected teacher.” This is a teacher who helps women to find their voice by encouraging them to be confident and to participate in the construction of knowledge.

Interpersonal engagement in learning underlies women's learning and development and it becomes even more impactful when accompanied by practices that allow women to learn through context(Belenky et al., 1986; Gwag, 2008; Maher & Tertrault, 1996; Rooser, 1990). Maher & Tertrault(1996) observed that female students understand and process information in regard to the context they are in, and that they access and acquire knowledge through shared opinions and discussion with others in the classroom. In other words, learning by relating to students' lives and social contexts is essential in order to facilitate female students' intellectual growth in higher education(Belenky et al., 1986; Maher & Tertrault, 1996; Rosser, 1990). Confirming the effects of such learning through relating to one's contexts, Belenky(1996) suggested making learning relevant to real life by offering exemplary models that students can relate to along with community-based learning. Rosser(1990) also emphasized wider employment of discussion on how the role of a scientist links to students' lives as well as the presentation of scientific discoveries using appropriate social context in STEM majors to improve female student's learning experience.

Research on gender differences in learning has steadily expanded, and subsequently, the suggestions for teaching practices to improve women's learning experience have diversified. Notwithstanding the value of later studies, Table 1 provides a summary of the principal notion of women-friendly education as derived from the studies based in the stream of feminist scholarly research that pioneered the conceptualization of women's knowing.

2. High-Impact Practices(HIPs) and career aspiration

High-Impact Practices(HIPs) are a comprehensive set of effective educational practices for college education(Seifert et al., 2007; Kilgo et al., 2015). HIPs revolve around Seven Principles of Good Practices—(1) student-faculty contact; (2) cooperation among students; (3) active learning; (4) prompt feedback to students; (5) time on task; (6) high expectations, and (7) respect for diverse students and diverse ways of knowing. These principles were found to be fundamental in encouraging students to get involved in their learning and to maximize their intellectual and career development during college(Chickering & Gamson, 1987; Kuh et al., 1997). Studies on HIPs categorize each HIP practice into three sub-domains: Learning by peer interactions, making the study contents relevant to students, and faculty support(e.g., Byoun, 2016b; Cabrera et al., 2002; Colbeck et al., 2001; Espinoza, 2011; Soldner, 2012; Watkins & Mazur, 2013). However, there has been a dearth of research into the effects of all sub-domains comprehensively on female students' persistence in the STEM stream.

In addition, each HIP domain can have differential effects to varying extents by student background, and gender is one of the prominent moderators in that regard(Astin & Astin, 1992; Bray et al., 2004; Cabrera et al., 2002; Kuh & Hu, 2001; Pascarella et al., 2014; Sax et al., 2005). HIPs, in fact, can be more effective in developing certain types of college gains of female students while still benefiting male students in different ways. The greater effectiveness of HIPs on female student's college development might be attributed to the nature of "connectedness," which reinforces positive learning experiences of female students. For instance, Cabrera et al.(2002) suggested that collaborative learning benefits female students' analytical thinking more than men's, but benefits male students' understanding of science. Sax et al.(2005) also revealed that students' interaction with faculty resulted in female students' higher gain of physical, emotional, and academic well-being relative to male students. On the other hand, interaction positively influenced male students' political engagement, social activism, and liberalism. Studies in South Korea also found gender-differential effects of faculty support on the gains of students in STEM majors(Byoun, 2016a; Byoun, 2016b; Kim & Lee, 2013).

While research on the linkage between HIPs and career aspiration is very scant, a few do indicate a positive relationship. Career aspiration is one of the meaningful educational outcomes that predict students' future success in their career preparation and development(Gray & O'Brien, 2007; Kim et al., 2016). Colbeck et al.(2001) revealed that students' engagement in collaborative learning practices in engineering majors exerted positive influences both on men and women in terms of motivation and confidence to become an engineer, yet it was more influential on women. Faculty support was also found to be the strongest factor explaining both the self-efficacy and the engineering major aspiration of female students(Kim & Lee, 2013). Faculty support was more impactful to female students' intention to pursue a career in STEM fields than to that of male students(Byoun. 2016b). However, whether study materials are relevant to students' contexts has not yet been studied in relation to students' career aspiration and self-efficacy. Nonetheless, the existing studies impliy comprehensive effects of HIPs on female students' success and persistence in the STEM stream(Espinoza 2011; Hurtado et al., 2007).

3. Conceptual/Analytic Model: Expanded social cognitive career theory including institutional factors

Social Cognitive Career Theory(SCCT) is a conducive framework for exploration and analysis of the relationship between learning experience and career aspiration(Lent et al., 2000). According to SCCT, career aspiration is shaped by learning experiences and cognitive factors such as self-efficacy, outcome expectation, and interest, which factors themselves are influenced by learning experiences (Lent & Brown, 1996; 2006). Besides learning experience, self-efficacy is known as the foremost determinant of career aspiration among the cognitive factors(Adedokun et al., 2012; Astin & Astin, 1992; Bandura, 1986; Lent et al., 2005).

In SCCT, self-efficacy mediates the relationship between learning experiences and career aspiration. More importantly, academic self-efficacy is considered to be the most influential in its role of mediating such linkage among different types of self-efficacy(Adedokun et al., 2012; Betz & Hackett, 1987; Lee & Choi, 2011). Kim and Park(2001) have developed measures for academic self-efficacy which have been applied in various studies in South Korea examining the roles of academic self-efficacy(Lee & Choi, 2018; Lim, 2019). They defined sub-domains for academic self-efficacy which are confidence, preference on task difficulty, self-regulated efficacy. These domains delineate a student's cognitive assessment on one's academic competence and belief in one's academic competence.

SCCT also highlights the effects of personal factors on career aspiration. Students' socioeconomic status and their academic achievement, for example, are important to career aspiration. Gender, race, and health status are personal input factors explicitly utilized in SCCT to explain one's career aspiration(Espinoza, 2011; Lee, 2000; Lee & Hwang, 2012; Yu & Cho, 2012). However, SCCT should consider other factors as well when studying the career aspiration development of college students in South Korea. First of all, college experience factors have been found to exert influence on the career aspiration of college students, and they are: one's year in school(Byoun, 2016b; Ko & Park, 2012), major(Eagan et al., 2013), college academic achievement(Eagan et al., 2013; Robbins et al., 2003) and financial concerns(Chang et al., 2014; Rhee, et al., 2013). In addition, high school type is a background factor to be considered. This is because depending on high school type, such as high schools specialized in science education and general high school, students have differential experiences of achievement and degree in their interest in science and math(Lee, 2012).

To better understand college students' career aspiration development, SCCT should be expanded to take institutional factors into account, mainly because the effects of undergraduate learning experiences on student outcomes can be altered by types of higher education institutions(HEIs) and their educational environments(Choi, & Rhee, 2013; Franke & DeAngelo, 2013). Moreover, credentialism adds further validity to the institutional effects on students' career aspiration in the South Korean context. This is because credentialism, in Korea, often is associated with judgement on college students' credentials based on the prestige and selectivity of the universities they attended. Having good credentials—by attending a highly ranked university—is correlated with upward mobility and career opportunities (Kim et al., 2016).

Two of the factors that determine whether an institution provides a good credential are location(metropolitan/non-metropolitan) and type(public/private) in South Korea. In fact, location(Byoun, 2016a) and type(Herrera & Hurtado, 2011) were found to be influential to female and minority students in undergraduate STEM courses. Rhee et al.(2013) also pointed out that research-oriented universities in Korea are mostly highly selective institutions. Thus, they claimed that the university's mission(teaching/research orientation) works in the same manner as its selectivity in influencing students' career-related outcomes. Another institutional factor to be considered is graduate-undergraduate student ratio at the university as a proximal factor for the university's mission. The reason is that four-year universities in South Korea have developed in such a way as to serve both missions, teaching and research(Lim, 2015). Therefore, graduate-undergraduate ratio can supplement the depiction of universities' current emphasis on either teaching or research.

The present study formulated an expanded model of SCCT that accounts for institutional effects. The model, as delineated in Figure 1, intended to explain the linkage between STEM students' learning experience with HIPs and their career aspiration. It suggests the sequential connection of students' personal background, college experience, HIPs, academic self-efficacy, and career aspiration in STEM majors.

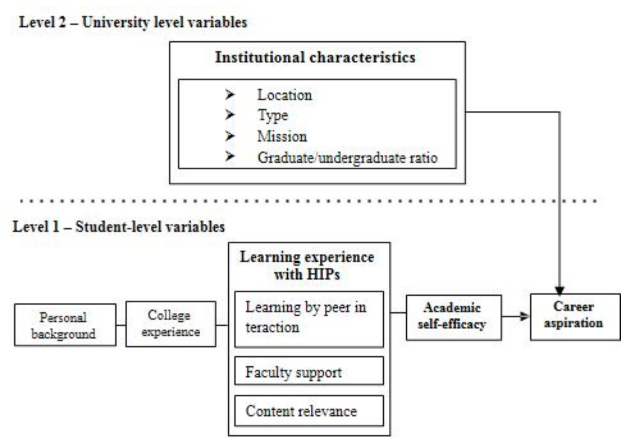

Fig. 1 Conceptual/Analytic model: A multi-level approach

III. Methods

This study intends to examine gender-differential effects of HIPs on the career aspiration of students in STEM majors. To be able to draw detailed understandings of the differential pathways of HIPs in influencing career aspiration, the same analytical model(Fig. 1) was applied separately to each gender group.

1. Data

The analyzed sample was derived from the National Survey on College Student Experiences and Learning Outcomes funded by the Korea Research Foundation and conducted from April to June 2012. This survey, the first comprehensive and representative one of college students in the nation, was specifically designed to understand college students' educational experiences and learning gains at 4-year institutions of higher education in South Korea.

Table 2 Sample characteristics for students

Student characteristics	Group	n	%
Gender	female	774	37
	male	1,327	63
College grade	year 3	1,200	57
	year 4	901	43
Major	math & science	776	37
	engineering & technology	1,325	63
Total		2,101	100

Table 3 Sample characteristics for institutions

Institutional characteristics	Group	n	%
Location	metropolitan	15	39
	non-metropolitan	23	61
Type	private	26	68
	public	12	32
Mission	research oriented	17	45
	teaching oriented	21	55
Total		38	100

Using stratified sampling, the 50 universities were randomly selected according to mission(research oriented/ education oriented) and location(metropolitan/non-metropolitan). At each university, five majors(departments) were randomly selected, and the pertinent students were asked to complete the survey. The initial sample was 6,666 undergraduate students in their third or fourth year. 1.1–2.2 % of junior and senior students were randomly selected at each university. The response rate was 69.3 per cent.

For the purpose of this study, the sample was limited to undergraduate students of STEM majors. As a result, it was reduced to 2,209 students at 38 universities. By list-wise deletion of missing variables of interest, the final sample was reduced to 2,101 students from 38 universities. The final sample in this study can still guarantee the gender representativeness of the population in terms of gender ratio. For instance, the female student ratio in our sample is 37 per cent, while the nationwide female student enrollment ratio in STEM majors is 33 per cent(WISET, 2018).

2. Measures

a. Dependent variable

Career aspiration was a composite measure of three survey items(Crobach's α =0.739) created by factor analysis using SPSS 25.0, and was then calculated by averaging out the sum of values from three survey items(see Table 4 for the composite scale). The items were: (a) becoming an authority figure in my field, (b) receiving recognition from peers for my contribution, and (c) making an academic contribution in a science/technology field. For each item, students were asked to respond on a four-point Likert scale.

b. Student-level independent variables

The student-level variables were student background characteristics, college variables, HIP variables, and academic self-efficacy. The student background variables were single-item measures such as first-generation status, family income, high school GPA, and high school type. In terms of high school type, general high school was set as the criterion variable, and the other types of high schools were coded as dummy variables.

The college-experience variables also were single-item measures, which students attain by attending college. Year in college was used as a dummy variable since the sample included only third-and fourth-year students. College GPA was measured by asking the specific average academic grade in college, ranging from D+ to A+. Financial concern represents how concerned a student is with college tuition payment, and was measured on a three-point Likert scale. Major was coded into dummy variables: Engineering and Technology, and Math and Science.

Learning experience with HIP variables were the key explanatory factors in this study. The HIP variables had three sub-domains: learning by peer interaction, content relevance of courses taken, and faculty support. Then, learning by peer interaction was divided into three sub-factors that are composite measures(see Table 4 for the composite scales). The three sub-factors were

Table 4 Composite Measures: Factor loadings and Cronbach alpha

Variable		Survey item	Scale	Factor loading	α
Career Aspiration		Becoming an authority figure in my field	1 = not important 2 = important a bit 3 = important 4 = much important	0.872	0.729
		Receiving recognition from peers for my contribution		0.868	
		Making academic contribution in science/technology field		0.688	
Learning by peer interaction	Out of class interaction	Discussing content with peers during non-class hours	0 = never 1 = sometimes 2 = frequently	0.730	0.657
		Helping other students' academics		0.787	
		Studying with peers		0.797	
	Discussion	Taking courses with discussion		0.865	0.662
		Participating in the discussion		0.865	
	Team project	Taking courses with team project or presentation		0.812	0.761
		Performing a team project with peers for the course		0.825	
		Giving presentation in class		0.832	
Content relevance		Satisfaction with relevance of courses with real life	1 = not satisfied at all ~ 5 = satisfied a lot	0.885	0.723
		Satisfaction with relevance of courses with my future career		0.885	
Faculty support	Faculty recognition	Feeling that professor gives me feedback whether I am doing well in class	0 = never 1 = sometimes 2 = frequently	0.833	0.787
		Feeling that I contributed something meaningful to the class		0.831	
		Feeling that professor encourages me to raise questions and participate in class discussions		0.848	
	Faculty mentorship	Academic Guidance or Counseling		0.755	0.794
		Emotional Support and Encouragement		0.795	
		Intellectual Challenge and Stimulation		0.748	
		Help to reach my career goal		0.790	
		Encouragement to Pursue Advanced Degree		0.632	

Table 5 Descriptive analysis and scales of student background, college-experience and HIP variables

Variable		M	SD	Min.	Max.	Scale
Background	First-Generation Status	0.60	0.49	0	1	1 = FGS, 0=Non-FGS
	Family income	2.72	1.24	1	6	1 = below US$2,000, 2 = $2,000~4,000, 3 = $4,000~6,000, 4 = $6,000~8,000, 5 = $8,000~10,000, 6 = above $10,000
High school	High school GPA	3.57	1.01	1	5	1 = low, 2 = between low and middle, 3 = middle, 4 = between middle and high, 5 = high
	Vocational[a]	0.05	0.22	0	1	1 = vocational, 0 = other
	Independent private[a]	0.02	0.15	0	1	1 = independent private, 0 = other
	Specialized[a]	0.02	0.14	0	1	1 = specialized, 0 = other
College	Major	0.63	0.48	0	1	1 = engineering & technology, 0 = math & science
	Year	0.43	0.05	1	2	1 = year 3, 2 = year 4
	College GPA	4.81	1.19	1	7	1 = D+ or below, 2 = C or C-, 3 = B- 4 = B, 5 = B or B-, 6 = B+, 7 = A or A-, 8 = A+
	Financial Concern	1.82	0.76	1	3	1 = not concerned, 2 = concerned a bit, 3 = concerned a lot
Learning by peer interaction	Out-of-class interaction	1.21	0.48	0	2	0 = never, 1 = sometimes, 2 = frequently
	Discussion	0.93	0.52	0	2	
	Team project	1.24	0.49	0	2	
Faculty support	Recognition	0.59	0.52	0	2	0 = never, 1 = sometimes, 2 = frequently
	Mentoring	0.80	0.46	0	2	
Content relevance		3.39	0.77	1	5	1 = not satisfied at all, ~ 5 = satisfied a lot
Academic self-efficacy		3.35	0.74	1	5	1 = 10% from the bottom, 2 = below average, 3 = average, 4 = above average, 5 = 10% from the top

[a] Criterion variable (General High School)

Table 6 Descriptive analysis of institutional characteristics and scales

Institutional variables	M	SD	Min.	Max.	Scale / calculation
Location	0.35	0.48	0	1	1=metropolitan, 0=non-metropolitan
Type	0.57	0.50	0	1	1=private. 0=public
Mission	0.49	0.50	0	1	1=research oriented, 0=teaching oriented
Graduate/ undergraduate student ratio	11.87	7.37	0.80	37.30	grad student / (undergrad + grad student) x 100

out-of-class interaction (α =0.657), discussion (α =0.662), and team project (α =0.761). Faculty support consisted of two sub-factors, which are composite measures: faculty recognition (α =0.787) and faculty mentorship (α =0.794). Content relevance was a composite measure (α =0.723) of two items related to student satisfaction with course relevancy to their intended career and life.

Academic self-efficacy is an important intermediate outcome of learning experiences in SCCT. It is measured by a single item asking students to assess their academic competence in comparison to the students at their age on a five-point Likert scale.[1)]

c. Institutional-level variables

The institution-level variables used in this study reflect the structural aspects that universities have had since their establishment. These variables represent the characteristics of our sample's 38 universities in which students were enrolled at the time the survey was conducted. The institutional variables used in our study are university type, location, mission, and graduate/undergraduate student ratio. The first three variables are single-item measures, and the last variable was produced by using the actual numbers of graduate and undergraduate students at each of the institutions.

3. Analytic method

The Hierarchical Linear Model(HLM) program version 6.8 was applied to the analysis. In addition, the theoretical model was tested by gender to make gender comparisons. First, an unconditional model was run with no explanatory variables specified at any of the levels. Second, the outcome was predicted by student-level and institutional variables as shown below:

a. Level 1 (Student level) model

$$Y_{ij} = \beta_{0j} + \sum_{p=1}^{6} \beta_{pj} Z_{\pi j} + \sum_{p=7}^{10} \beta_{pj} W_{\pi j} + \sum_{p=8}^{16} \beta_{pj} X_{\pi j} + \sum_{p=17}^{18} \beta_{pj} C_{\pi j} + e_{ij}, e_{ij} \sim N(0, \sigma^2)$$

where denotes the mean career aspiration of students at institution j, and indicates the individual effects of student i at institution j on career aspiration. The outcome was predicted by student-level variables: (a) student-background characteristics, which were first-generation status, family income, high school GPA, and high school type; (b) college-experience variables, which covered major, year, college GPA, and financial concern; (c) HIPs for women, which were learning by peers, content relevance, and faculty support, and (d) academic self-efficacy, which was used as an intermediate outcome variable.

b. Level 2 (Institutional level) model

$$\beta_{0j} = \gamma_{00} + \sum_{s=1}^{4} \gamma_{0s} T_{sj} + u_{0j}, u_{0j} \sim N(0, \tau)$$

where represents the mean Y among the students from all institutions, and u_{0j} signifies the gap between the mean Y of each institution and the mean Y among the students from all of the institutions. In short, this equation explains the institutional effectiveness of institution j as determined by the differences between institutions. The mean of u_{0j} was also 0, and followed a distribution with variances defined by τ_{00}. The institutional factors included university location, type, mission, and graduate/undergraduate student ratio.

IV. Findings

1. Gender difference in career aspiration

According to the base model(Table 7), the career aspiration

1) In a strict sense, it measures academic self-concept rather than academic self-efficacy, which is context specific and future-oriented(Sander & Cardiff, 2006).

of female students was about 2.65, and that of male students, 2.90. This serves to highlight the gender discrepancy in career aspiration among students in STEM majors. Differences between female (B=2.64, $p<.001$) and male (B=2.91, $p<.001$) students also were found even when other key variables were controlled in the analytic model(Table 8). The ICCs and reliability were calculated through a basic model analysis for each gender. It was observed that the student-level variance(within variance) accounted for 92.1 per cent of the total variance of female students' career aspiration, while institution-level variance(between variance) accounted for 7.9 per cent. For male students, student-level variance explained 95.8 per cent of the total variance of career aspiration, and institution-level variance 4.2 per cent. When the ICC is lower than 5 per cent, it is considered that the results produced through the HLM and those through OLS are not significantly different(Astin & Denson, 2009). Since the χ^2scores were statistically meaningful ($p<0.001$) for each gender, however, the differential degrees of institutional and individual level effects should be discussed for each gender.

Table 7 Results from basic model of female students and male students

Female students				
Fixed effect	Coefficient	S.E.	t	R
Career aspiration	2.6459	0.0459	57.675	0.644
Random effect	Variance	df	χ^2	ICC
Between(τ_{00})	0.0448(7.9%)	31	88.856***	0.079
Within(σ_2)	0.5204(92.1%)			

Male students				
Fixed effect	Coefficient	S.E.	t	R
Career aspiration	2.9026	0.0304	95.568	0.576
Random effect	Variance	df	χ^2	ICC
Between(τ_{00})	0.0202(4.2%)	36	90.998***	0.042
Within(σ_2)	0.4565(95.8%)			

*p<.05, **p<.01, ***p<.001

2. Gender-differential effects of HIPs and academic self-efficacy

The HIPs generally showed positive influences on career aspiration for both genders. However, specific practices that were influential and the degree of influence differed by gender. For instance, in the learning by peer interaction domain, out-of-class interaction commonly had positive effects on the career aspiration of both females (B=0.18, $p<0.001$) and males (B=0.08, $p<0.1$), and yet it had a greater influence on ($p<.001$) had a positive influence only on female students' career aspiration. In the faculty support domain, faculty mentorship was the only statistically influential practice, and had positive linkage with the career aspiration of both female ($p<.05$) and male ($p<.001$) students. However, the influence of mentorship was larger for male students' (B=0.21) than for female students' career aspiration (B=0.16). The content relevance domain was found to have a positive influence on the career aspiration of both female ($p<.05$) and male ($p<.01$) students, yet with relatively greater effects on female students (B=0.09) than on males (B=0.07).

Academic self-efficacy, an intermediate outcome of HIPs, was found to have a positive relationship with female ($p<.001$) and male students' career aspiration ($p<.001$). More importantly, academic self-efficacy had the greatest influence on the career aspiration of both female (β=4.47) and male students (β=5.02), considering all factors in the study. In fact, the out-of-class interaction with peers (β=3.30) and discussion in classroom (β=3.11) HIPs were, respectively, the second strongest predictors for female career aspiration, and male faculty mentorship (β=4.16).

3. Gender-differential effects of personal and institutional factors

First-generation status ($p<.01$) was the only personal background factor that showed statistically meaningful influence on female students' career aspiration. To be specific, female students neither of whose parents went to college had lower career aspiration than did students for whom at least one parent had a bachelor's degree or above. Personal background factors were not found to have meaningful effects on the career aspiration of male students. College-experience variables were not found to have any statistically meaningful relationships with female students' career aspiration, whereas they exerted a significantly meaningful influence on that of male students. For instance,

Table 8 Results of HLM analysis of career aspiration by gender

	Female			Male		
	B	β	S.E.	B	β	S.E.
intercept	2.64 ***	79.25	0.03	2.91 ***	116.88	0.02
Student background variables						
First-generation Status	-0.10 +	-2.03	0.05	-0.01	-0.39	0.04
Family income	-0.02	-1.08	0.02	0.01	0.84	0.01
High school GPA	-0.01	-0.54	0.03	-0.02	-1.13	0.02
Vocational high[a]	0.09	0.92	0.09	-0.12	-1.13	0.11
I. Private high[a]	-0.25	-1.30	0.19	0.00	0.03	0.08
Specialized high[a]	0.15	0.99	0.15	0.14	1.51	0.10
College experience variables						
College year	-0.02	-0.43	0.05	-0.07 +	-1.75	0.04
GPA	0.02	0.85	0.02	0.05 **	2.61	0.02
Financial concern	0.05	1.27	0.04	0.06 **	2.98	0.02
Major (Engineering)	0.00	-0.02	0.06	0.04	0.81	0.05
High-Impact Practices (HIPs)						
Learning by peer interaction						
Out-of-class interaction	0.18 ***	3.30	0.05	0.08 +	1.71	0.05
Discussion	0.17 ***	3.11	0.06	0.06	1.18	0.05
Team project	-0.02	-0.30	0.07	-0.01	-0.26	0.05
Faculty support						
Recognition	0.09	1.27	0.07	0.00	0.05	0.04
Mentorship	0.16 *	2.09	0.08	0.21 ***	4.16	0.05
Content relevancy of courses taken						
Content relevance	0.09 *	2.42	0.04	0.07 ***	2.63	0.02
Intermediate outcome variable						
Academic self-efficacy	0.14 ***	4.47	0.03	0.15 ***	5.02	0.03
Institutional characteristics						
Location	-0.40 ***	-3.61	0.11	-0.10	-0.85	0.12
Type(private)	0.30 *	2.42	0.12	0.09	1.30	0.07
Mission	-0.24 *	-2.53	0.10	-0.07	-0.86	0.08
Grad/undergrad ratio	0.02 **	2.90	0.01	0.01 +	1.95	0.01
Random effect						
Between variance	0.0245			0.0140		
Within variance	0.4552			0.3985		
ICC	0.051			0.034		
df	27			32		
χ^2	60.9896***			69.3709***		

+p<0.1, *p<.05, **p<.01, ***p<.001 / Note: [a] the criterion variable for high school type is general high school.

year was negatively associated with male students' career aspiration (p<.10). College GPA had a positive link with male students' career aspiration (p<.05). Financial concern for tuition also had a positive relationship with the career aspiration of male students (p<.05).

Although all of the institutional factors(location, type, mission, grad-undergrad ratio) were influential on female students' career aspiration to varying degree, only graduate-undergraduate ratio at the university in which students were enrolled showed a statistically positive influence on male students' career aspiration ($p<.05$). To be specific, metropolitan location was negatively associated with female students' career aspiration ($p<.001$). Private university type was found to have a positive relationship with female students' career aspiration ($p<.05$), unlike the case for public university. Research-oriented university was negatively influential on female students' career aspiration ($p<.05$). On the other hand, graduate-undergraduate student ratio was found to be influential on female students' career aspiration ($p<.05$), meaning that the higher the number of graduate students enrolled in comparison to undergraduate students at the student's university, the higher the career aspiration female students tended to have.

V. Discussion

In our study, the female students in their third and fourth years in STEM majors in South Korea had lower career aspirations than male students, which is consonant with previous studies(Do, 2008; Oakes, 1990; Lent, Brown, & Hackett, 2000). In addition, HIPs were found to have positive effects on career aspiration of students in STEM majors, but gender-differential effects were observed. To be specific, female students gained benefit by 1) studying with peers out of classroom, 2) in-class discussion with peers, 3) faculty mentoring on academics and career with encouragement and 4) relevant class materials to their lives and careers. Out of classroom interaction, faculty mentorship, and content relevance also positively influenced the career aspiration of male students to differing degrees. These findings support the notion that relational aspects of learning play a larger role in women's knowing and encourage STEM majors to consider such aspects in their curriculum. In fact, learning communities, undergraduate research courses, and small-group seminars are recommended to be included in the curriculum, since these practices tend to facilitate HIPs(Chickering & Gamson, 1987; Kuh, 2008).

However, it is necessary to pay heed to some caveats when implementing HIPs in STEM majors. In the current study, team projects, a sub-factor of learning by peer interaction, did not have a significant impact on female students' career aspirations, whereas two other sub-factors in the same domain did. This might have been due to the gender ratio in the team assigned for a project. For example, team projects are usually carried out with a small group of students. While there may be multiple male students, there is often only a single female student in the group. Thus, female students might feel more underrepresented in such an environment in comparison to a classroom discussion environment. In a meta-analysis on the effects of small-group learning by Springer et al.(1999), small-group learning had a greater influence on female students' achievement when they were the majority in the small group compared to when they seemed underrepresented. In addition, the negative effects of female students' first-generation status were not offset with HIPs. This finding can be taken to emphasize that HIPs cannot be a panacea in improving the learning experiences of female students from socioeconomically marginalized backgrounds.

The findings of this study also reflect the critical influence of academic self-efficacy on female students' career aspiration. Self-efficacy with regard to the perception of one's academic ability was found to be the most important precursor to the development of career aspiration for both male and female students in STEM majors. In our study, interestingly, college GPA—actual academic performance—did not have a meaningful linkage with female students' career aspiration, whereas it did have a positive relationship with male students' career aspiration. This finding may support the argument that women are prone to opt out of the STEM stream due to negative self-psychological evaluation of their ability and their environment rather than their actual ability(Hackett & Betz., 1981; Kim & Lee, 2013). Therefore, rather than focusing on students' high academic performance and competition(Astin & Astin, 1992), courses in STEM majors should be designed with learning activities promoting female students' academic self-efficacy. In sum, higher education is required to redouble its efforts to improve female students' experiences of learning in their majors, with the aim of enhancing their sense of competence in what they are learning as well as their actual competency.

Furthermore, the findings on the various institutional effects shed light on the institutional environments that facilitate female students' positive experience with faculty teaching practices and supports. For instance, female students exhibited higher career aspiration when their university was located in a non-metropolitan area, was teaching-oriented, or private compared with the female students attending universities with contrary features. Those institutional features with positive impacts are postulated to encompass an educational environment promoting the increased role of teaching and faculty support. For instance, universities in non-metropolitan areas are small and teaching-oriented(Byoun, 2016a). Private universities have a higher ratio of full-time faculty members on campus compared to public universities(Kang, 2014), which allows students to enjoy more contacts with faculty members on campus compared to public universities(Kang, 2014). In addition, the number of graduate students per undergraduates where a student exhibited a positive linkage with the career aspirations of both genders. Although this ratio was used as a proximal factor for universities' mission in this study, it may be more related to universities' selectivity in the South Korean context(Rhee et al., 2013). This is due to the fact that selective universities in Korea, regardless of their mission(teaching or research), tend to have a larger share of graduate students than do less selective universities.

Ⅵ. Conclusion and Recommendations

One of the major findings of this study is that there is a gender discrepancy in career aspirations among undergraduate students majoring in STEM majors in South Korea. However, the findings on gender differential effects of HIPs provide a comprehensive understanding on meaningful educational practices that can reduce such gap and increase the effectiveness of collegiate STEM education to retain more women in STEM pipeline.

Notwithstanding the contributions of the present study, there were certain limitations. First, because the data we used was cross-sectional in nature, we were unable to include a pre-college career aspiration variable. So, with the findings drawn from the study, it is challenging to comprehend exactly how influential HIPs have been on student's career aspiration development throughout their college years. This limitation imposes the necessity of a longitudinal study that can trace the impact of HIPs on the career-related development of female students in STEM majors.

Second, more up-to-date data needed to be collected and analyzed. The data used in this study were collected in 2012, and thus might be considered to be somewhat outdated to reflect the current situation. Nevertheless, we decided to use it, because, among the few national datasets available on higher education, such as the Korean Education Longitudinal Study(2005-2018), the Korean Educational Employment Panel(2004-2016), and the Youth Panel (2007-2017), the data we chose were most appropriate for the purpose of this study in terms of the variables of interest. However, for the last few years, non-college-education factors might have started playing larger roles in the career decisions of female students in STEM majors. For instance, work-life balance is more valued by the younger generation in the ways in which they carry out their lives in South Korea(Min, 2018). Thus, future research will use or design more recent data that allow for more comprehensive investigation of newly changing social values.

Finally, this study was limited to a focus on academic self-efficacy; it did not consider outcome expectations and interests, which are also important dimensions of SCCT. Hence, to gain a holistic understanding of the sequential linkage between HIP practices and career aspiration, it would be important to investigate whether the effects of those additional factors do mediate HIPs.

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