

Exploring Gender-Based Career Capital Perceptions among Engineering College Students: A Qualitative Interview Study

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Abstract: In recent years, diversity has emerged as a critical topic of discussion in the field of science and technology in Korean society. In particular, gender diversity has garnered attention in engineering, highlighting the need to develop gender-based competencies among engineering college students. The purpose of this study is to explore the career capital perception of gender-based engineering college students. This study employs focus group interviews to investigate the gender-based perceptions of career capital competency among engineering college students. Focus group interviews, a qualitative research method, involve discussions with small groups (typically 4 to 12 participants) on a specific topic. In this study, two focus groups were formed and divided by sex, comprising 6 male and 6 female students, with a total of 12 participants. The interviews were conducted, transcribed, and analyzed to uncover participants' perceptions of career capital, which consists of knowing-why, knowing-how, and knowing-whom. The results of the study revealed that, among the career capital recognized by engineering college students, motivation (an aspect of knowing-why) and knowledge and skill (aspects of knowing-how) were perceived uniformly across genders. In contrast, attitude and identity (aspects of knowing-why), ability (an aspect of knowing-how), and networking and information resources (aspects of knowing-whom) exhibited gender-specific perceptions. The results of this study emphasize the importance of the need to develop competencies in consideration of the gender perspective in order to accumulate career capital of engineering college students, contributing positively to career capital enhancement in engineering education. The study's findings serve as primary data for designing gender-based career capital programs.

Keywords: Gender, Career Capital, College Students in Engineering, Interview, Motivation, Knowledge, Skill, Ability, Attitude, Identity, Networking, Information Resources, Gender-based Competencies

1. Introduction

Globally, governments are placing greater emphasis on the diversity and inclusiveness of human resources in the STEM field. Particularly in Korea's engineering sector, embracing gender diversity is becoming increasingly crucial. Fostering greater diversity and inclusion in science and technology promises not only improved performance in research and development but also boosts competitiveness[1]. Consequently, securing female engineering talents has become crucial. However, as of 2021, female students comprised only 25.8% of those majoring in engineering, a stark contrast to other disciplines such as natural science (53%), medicine (64.8%), humanities and social sciences (58%), and others (63.4%). In addition, the gender gap in the economic activity participation rate was

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most pronounced in engineering (23.1%), surpassing rates in natural science (19.8%), medicine (14.8%), and the humanities and social sciences (19.9%). These figures highlight engineering as having the highest gender gap in economic activity participation rate across all majors, underscoring the prevailing male-centered character of the engineering department and the persistence of gender imbalance[2].

Addressing gender imbalances in engineering requires approaches beyond merely finding solutions to educational and institutional challenges. New perspectives on gender issues in engineering have been introduced[1], highlighting the significance of a gendered perspective. Gender perspective refers to a frame that constructs daily experiences based on the self-awareness that women themselves are the subjects of life and constitutes roles and competencies to move individuals and organizations[3]. In engineering education, adopting a gender-based approach is essential. The objective is not only to boost the interest and self-efficacy of female students but also to promote an understanding of the cognitive and psychological characteristics of men and women, thereby fostering competency in recognizing and embracing diversity[4]. Therefore, incorporating a gender-based approach into engineering education in Korea is becoming increasingly important. From a gender perspective, it underscores the essential role both female and male students play as co-workers and actors who share experiences together[5]. Consequently, developing competencies, cultivating a sense of self-efficacy, and deriving pleasure from their engineering journey should be a shared priority for both genders[6].

Specifically, in the field of engineering, understanding the gender differences among engineering college students is vital. The current research suggests that the higher dropout rate among female engineering students compared to their male counterparts can be attributed to a lack of consideration and understanding of gender dynamics in engineering education[4]. In the 21st century, where knowledge reigns supreme, the relationship between engineering and gender remains complex. If one gender dominates or there is inadequate understanding and consideration for the other gender, it hinders the seamless integration of communication skills, creativity, emotions, and scientific knowledge and abilities[4].

Recently, the gender perspective has been gaining attention, especially as the emphasis is placed on developing the competencies of female engineering college students and training personnel in convergence technology[3][7]. This necessitates exploring the factors that influence competency development in the engineering domain, which involves pursuing gender-based strategic education content and methods tailored for engineering college students[8].

The existing research on gender in engineering has explored aspects such as women's leadership[3], teaching strategy development[4], and engineering education[9]. While this research holds academic value in enhancing an understanding of gender in engineering through gender-based approaches, its scope is limited in that it does not directly contribute to developing gender-based competencies for women in engineering.

In light of this, the present study focuses on examining career capital in relation to the competency of engineering college students, with a particular emphasis on gender. Career capital comprises three dimensions of knowing[10][11]—knowing-why, knowing-how, and knowing-whom, as defined by DeFillippi and Arthur[12]. Knowing-why refers to an individual's career-related attitudes and perspectives, intertwined with their identity, motivation, and energy toward their career pursuits[11][12]. Knowing-how represents work-related skills, knowledge, and competencies[10][12], while Knowing-whom is associated with a professional network, including attachments, relationships, information resources, and career-related obligations[11][12]. This competency comprises formal and informal connections[12] and incorporates family, friends, and professional acquaintances[11], contributing to an individual's ability to successfully pursue a boundaryless career[12]. Baruch emphasizes the link between these individual competencies, highlighting their role in accumulating career capital[13]. Considered an antecedent to career success[14], career capital is deemed an important competency for career development, especially in the field of science and technology. The lack of career capital in

science and technology has been reported to impede career advancement, thereby highlighting the growing importance of its development among engineering college students[14][15]. Meanwhile, there exists an extensive body of research on career capital; however, gender issues have not been explicitly addressed. It is believed that an understanding of career capital can be better achieved by taking into account diverse gender experiences within this context[14]. In particular there is a growing need to connect career capital concepts with the career experiences of women in engineering, promoting a more thorough exploration of these concepts[14]. Therefore, a crucial aspect of understanding career capital lies in continuously exploring what it is and how to accumulate it.

However, there remains a disparity in the development and accumulation of career capital between female and male students, with female students at a disadvantage[14][16]. Consequently, this study aims to understand gender-based differences and investigate career capital reflecting gender characteristics. In doing so, the study explores gender-based perceptions of career capital among engineering college students. This study attempts to answer the following questions: 1) How do female students in engineering colleges perceive career capital? 2) How do male students in engineering colleges perceive career capital? 3) What are the differences in the gender-based perception of career capital among engineering college students? 4) What are the commonalities in the gender-based perception of career capital among engineering college students?

2. Research Methodology

2.1 Research Design

This study adopts a qualitative research approach, employing focus group interviews with engineering college students to explore gender-based perceptions of career capital. Since FGIs prioritize capturing a wide array of opinions over a consensus among experts[17], this study specifically opted for this method. This qualitative approach facilitates data collection by enabling participants to talk freely about specific topics within specific groups. Participants were selected based on their common characteristics related to the topic, creating a context that allowed them to freely share their perceptions and perspectives without the need to reach a consensus[18]. This study involved focus group interviews coupled with qualitative content analysis to explore gender-based career capital perceptions by recording the career-capital-related experiences and opinions of engineering college students.

2.2 Respondents of the Study

The respondents in this study were college students enrolled in the engineering department of a Korean university. The study employed focus group interviews, involving small groups discussing a specific topic, typically ranging from 4 to 12 subjects[19]. The group's composition is crucial for fostering a comfortable and productive conversation[20]. To ensure this, the study organized students from the same university and the same major during the interview process to facilitate a smooth and comfortable atmosphere for conversation. Two focus groups were formed and divided by gender, with 6 male and 6 female students, totaling 12 participants. Participants' names and their exact majors were not included to protect participant privacy, though the major was identified as engineering. [Table 1] displays the participant information.

[Table 1] Participant Information

Category	Years in school	Age	Gender	Major
A	3	24	Male	Engineering

B	3	24	Male	Engineering
C	3	24	Male	Engineering
D	4	25	Male	Engineering
E	4	26	Male	Engineering
F	4	25	Male	Engineering
G	3	22	Female	Engineering
H	3	22	Female	Engineering
I	3	21	Female	Engineering
J	4	23	Female	Engineering
K	4	23	Female	Engineering
L	4	23	Female	Engineering

2.3 Data Gathering Procedures

Data for this study were collected from 12 engineering college students from a national university in December 2022. The subjects were recruited after they fully understood the study's purpose and voluntarily agreed to participate. The interviews were recorded with their informed consent. The interview questions were formulated in line with the components of career capital proposed by DeFillippi and Arthur[12], specifically addressing 1) knowing-why, which relates to career attitude, motivation, and identity; 2) knowing-how, which relates to knowledge, ability, and skill; and 3) knowing-whom, which refers to networking and information resources.

Each focus group session, for both males and females, lasted approximately 2 hours. Participants were asked to elaborate again to ensure clarity and address any ambiguity in the data's content. During the interview process, we adjusted the question order or even added or omitted questions as needed to avoid interrupting the participants' flow of thought. All discussions were carefully recorded and transcribed verbatim after the interviews. To enhance the validity of the transcripts, we repeated the recordings and confirmed any unclear sections with the participants.

2.4 Data Analysis

We collected and analyzed the data using Miles and Huberman's[21] three-step qualitative analysis approach. This sequential and interactive process involved simplifying the data, organizing it, and deriving and confirming the conclusions. First, simplifying the data involved selecting and summarizing key information, repeating the conversion process, and cross-checking to identify commonalities and differences. Second, organizing the data involved reorganizing the collected information and confirming the main data related to career capital perception by gender. Finally, to interpret the key information and study results, we summarized the data on gender-based career capital perception and identified the commonalities and differences between genders.

2.5 Validity Verification

While qualitative research methods are often called into question for their inability to measure validity and reliability—aspects more commonly associated with quantitative research—Lincoln and Guba[22] propose the member check as a valuable means to enhance reliability. In this study, we applied member checking by asking interviewees to review their interview results, contributing to validating the results. To assess the applicability of our findings to individuals in similar contexts, we shared the research results with two male and two female students from the same university as the research participants,

confirming the validity of the research results in light of their experiences. Additionally, a researcher with extensive experience interviewing engineering students reviewed the results, further strengthening the validity of the analysis.

3. Results and Discussion

This study explores the perception of career capital among engineering college students by gender. As previously discussed, career capital comprises knowing-why, knowing-how, and knowing-whom[13]. The results are as follows:

3.1 Knowing-Why

3.1.1 Attitude Toward Career

The study participants exhibited gender differences in their attitudes toward their careers. In particular, challenging and active attitudes were perceived as important among male participants.

My seniors advised me that acquiring new knowledge is essential for working after graduation. In order to acquire diverse knowledge and skills, I believe it is necessary to have the attitude of actively challenging myself and gaining varied experiences during my university years. (Participant A, male)

With so many variables in experimentation, having diverse experiences becomes crucial. It is important to actively engage in and experiment with a lot of experiences. (Participant B, male)

Engineering college students may encounter difficulties in their academic pursuits in the future if they fail to thrive in their studies. Given the frequent tests and projects, maintaining concentration and a sincere attitude toward their studies is critical[23]. Furthermore, female participants in this study perceived a sincere and patient attitude as important.

Since what you learn in the freshman and sophomore years continues to deepen, if you don't put in the effort in the freshman year, it becomes challenging to understand the material as the grade advances. The basic knowledge in the freshman and sophomores is crucial, so I believe concentrating in class and studying with a sincere attitude will be helpful. (Participant G, female)

In class, I felt that it was fun and that there was not much difficulty. However, I frequently struggled when I attempted to solve problems on my own at home. Therefore, I decided never to miss the class. I do not think I should give up too quickly, even if it is difficult. I try to approach my studies with patience and concentration. (Participant L, female)

3.1.2 Motivation

Traditionally, affinity for engineering, an interest in technology and machinery, and a preference for science subjects in secondary school are the factors that influence students' selection of an engineering major[24]. The participants in this study chose engineering as their major because of a motivation driven by their interest in and preference for mathematics and science subjects for their career:

I have always had a passion for math and science, so when it came to choosing a major, engineering felt like the right choice. (Participant I, female)

In high school, I did better in science and math than in English or social studies. My parents suggested that I pursue engineering, considering it would be a better fit for me than the humanities. I was confident in my abilities in math and science, and I entered engineering college with my parents' consent. (Participant, K, female)

When contemplating my major and career, I wanted to choose a field where I could actually do well. I was into math and science; therefore, I was confident I would excel in this field. (Participant E, male)

When I chose my major, I constantly considered finding a subject that sparked my interest. I realized I was good at math and science than my friends, leading me to choose engineering as my major. (Participant D, male)

3.1.3 Identity

Male participants expressed a strong sense of identity as engineers, envisioning themselves as future leaders in their field with pride and confidence in their major.

I want to become an engineer who takes pride in their work while developing environmentally friendly materials. (Participant F, male)

When I see famous engineers I admire in lectures or on media platforms, I dream of achieving that level of recognition and confidence in my field. (Participant B, male)

On the other hand, a prior study found that female engineering students' early university experiences help them deepen self-understanding and regain confidence in their chosen major, thereby allowing them to develop a vision and confidence as future engineers[23]. The female participants in this study also aspire to contribute to society as skilled and visionary engineers.

I aim to become a highly competent engineer with expertise in my field so that I can contribute to creating a safe and environmentally friendly society for people. (Participant J, female)

While majoring in engineering, I thought of ways to boost my cell phone's battery life, instilling in me the habit of identifying problems in my everyday life that need solutions. As I gain professional expertise, I want to utilize it to help people overcome these everyday discomforts. (Participant L, female)

3.2 Knowing-How

3.2.1 Knowledge

Both male and female participants in this study uniformly recognized the importance of acquiring core knowledge in the engineering curriculum.

I think a good grasp of major knowledge is crucial in engineering. For instance, strong skills in chemistry can lend you a job or demonstrate your ability at work. I believe acquiring this major knowledge at university is beneficial. (Participant C, male)

I think accumulating knowledge in my field of study is helpful because having 'in-depth knowledge of my major will be beneficial in the long run. (Participant I, female)

I have always emphasized the importance of acquiring basic knowledge in my major during classes. I believe that understanding the foundations of my major is essential due to the specialized nature of the engineering field. (Participant J, female)

Having a strong knowledge base translates into good grades, making future studies like certifications and specializations much more convenient and helpful. (Participant A, male)

3.2.2 Ability

Creativity is perceived as a key ability for future engineers, and creativity education is also a significant focus in engineering education[25]. The male participants in this study perceived creativity and problem-solving as crucial abilities in the field of engineering.

I think creative ideas are important because engineering evolves rapidly. Falling behind translates into losing relevance, so you must constantly try different experiences to learn about new developments. (Participant B, male)

I aspire to be a creative individual with many original and innovative ideas. When I study, I contemplate new approaches to explore alternative points of view. (Participant E, male)

When I encounter a problem, my approach to solving the problem involves constant questioning and thinking. I think the ability to solve diverse problems effectively is an essential skill. (Participant F, male)

Meanwhile, according to a study[26], engineers in the 21st century global society assert the necessity of lifelong education competency on the world stage and the importance of English proficiency for reading, analyzing, writing, and communicating with related materials. The female participants in this study also emphasized foreign language ability as a critical ability in their careers.

English materials are frequently used in class. Of course, the professor explains well in Korean, but I believe proficiency in English would significantly enhance my understanding of the class. (Participant K, female)

I often come across the latest English papers in class, but if I miss a class, it requires considerable time to catch up to the material independently. Consequently, I believe I should possess strong foreign language abilities to major in engineering. (Participant H, female)

3.2.3 Skills

In engineering, a positive correlation exists between strong social skills, overall general ability, and salary levels[27]. This study found that participants of both genders perceived the importance of social skills.

Not many females are in our field, so it is crucial to acquaint ourselves and exchange information. Without enough social skills, it will not be easy to get along. (Participant G, female)

In our major, only four female classmates are in the same semester. Our school has a women's meeting where we share numerous stories and information. Strong social skills definitely make such meeting activities more impactful and helpful. (Participant J, female)

I want to learn how to get along with my colleagues, seniors, and professors at school. This enables me to seek help when I am stuck and offer the same support to my juniors. (Participant D, male)

There were occasions when I felt envious because my friends with good social skills participated in numerous programs and seemed to have an extensive network. (Participant C, male)

3.3 Knowing-Whom

3.3.1 Networking

Parents and professors play essential roles in networking within engineering. Their support and encouragement substantially impact engineering college students by promoting identity formation, career pursuit, motivation, interest in engineering, and the desire to learn[28][29]. While the research participants acknowledged the value of parental support for an engineering career, male students were relatively less influenced by their support system compared to female students:

While I think receiving support from my parents would be beneficial, I also believe I could manage even with limited support. In any case, I think it is essential to independently study and prepare for employment. (Participant A, male)

I think it is important to work hard on my own. However, considering the small number of female students, having people who can support them would be helpful. (Participant D, male)

My father believed that engineering would be a good fit for me and that I could do well in it. This assurance allowed me to enter the engineering school without worrying. (Participant H, female)

My mother strongly advised that I attend engineering school. Having harbored a love for math and science since middle school, she continuously considered my strengths while raising me. I think her support was particularly instrumental when I went to engineering school. (Participant K, female)

3.3.2 Information Resources

The male student participants in this study acquire the necessary information and data for the engineering field through data searches and active participation in case-based workshops:

If I need information or have a specific interest, I can search the Internet. I can quickly access information and solve my questions through online searches. (Participant E, male)

I enjoy participating in workshops and listening to different stories and the latest information. Direct participation allows me to observe trends in my major field, and engaging with other participants makes it fun and enriching. (Participant F, male)

Conversely, according to prior research, female engineering college students primarily utilize the career development center designed for female students. They also engage in programs that offer information on job preparation, such as resumes and interview clinics[30]. The female participants in this study also rely on their university's career job center as an important information resource:

I usually get job-related information from the job center. Sometimes, I feel limited when gathering information on my own. I wish a personalized program could assist in finding information and securing

a job. (Participant I, female)

I also participated in a job center program that focused on resume writing and crafting a self-introduction letter. This program helped me learn how to write a self-introduction letter; I have been updating it since then. (Participant L, female)

As mentioned above, this study examined the gender-based differences and commonalities in the perception of career capital among engineering college students. Paying attention to the experiences of career capital between genders enhances understanding of the concept[14]. In other words, to better understand career capital, it is essential to acknowledge gender-based differences and recognize the importance of career capital by exploring its definition and how to accumulate it.

The results of this study are as follows:

[Table 2] Gender-based commonalities and differences

Career Capital	Gender-based commonality	Gender- based difference
Knowing why	Motivation	Attitude, Identity
Knowing how	Knowledge, Skills	Ability
Knowing whom		Networking, information resources

4. Conclusion

This study employed focus group interviews to investigate the gendered perceptions of career capital among engineering college students. The analysis concluded that students across genders shared commonalities in their perceptions. It was observed that these common perceptions revolved around the motivation of knowing-why and the knowledge and skills of knowing-how. These findings align with a previous study, showing that a strong interest in mathematics and science during middle and high school fuels students' motivation to pursue engineering degrees[31][32]. Furthermore, both male and female engineering students in this study recognized the importance of major knowledge and social skills. Simultaneously, social skills are recognized as important for student learning and career commitment in engineering[28]. Therefore, it is necessary to deepen the major knowledge considering the gender characteristics of engineering students and create an educational environment conducive to developing social skills.

On the other hand, there were differences in the perception of attitude and identity (knowing-why), ability (knowing-how), and networking and information resources (knowing-whom) between genders. Regarding the ability of *knowing-how*, male students perceived creativity and problem-solving abilities as crucial. Therefore, offering diverse experiences and opportunities in the engineering education system becomes essential to foster creativity, benefiting both male and female engineering college students. In addition, regarding networking and information resources (knowing-whom), this study found that female students exhibited a heightened awareness of the need for a support system than male students. The support system for engineering female college students was found to positively affect career choice and efficacy[33]. In this regard, our study identifies a crucial need for adaptations in the curriculum and the implementation of mentor-mentee programs.

This study reveals a common perception among engineering students between genders regarding the motivation of knowing-why and the knowledge and technology of knowing-how. At the same time, differences in perception emerged between genders regarding the attitude and identity of knowing-why, the ability of knowing-how, and the networking and information resources of knowing-whom. The findings of this study can significantly contribute to strengthening gender-based competencies by

considering gender characteristics in engineering education. In addition, the results of this study can provide useful implications for policy development for engineering educators and gender-based competency development. Therefore, it is necessary to conduct a lot of gender-based approach research.

Suggestions for follow-up studies include conducting additional research that investigates the underlying factors contributing to the observed differences in perceptions, taking into account variables such as the academic volume, complexity, or educational environment of major subjects. Furthermore, due to the exclusive focus of this study on engineering juniors and seniors, its findings are specific to exploring their gender-based career capital perceptions. Hence, the generalizability of this study to all students is limited. Future research may examine the trends in career capital across different grades and majors from the freshman to the senior years. This study highlights the need for gender-based approaches to developing career capital competencies in engineering college students. It suggests developing complementary career capital competencies, considering gender differences and commonalities. These findings serve as preliminary data that informs the development of gender-specific career capital competencies among engineering college students.

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