WOMEN'S EXPERIENCES IN UNDERGRADUATE ENGINEERING PROGRAMS IN JAPAN AS RESOURCES TO THE DECISIONS TO PURSUE MASTER'S DEGREES

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by

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The undersigned, appointed by the dean of the Graduate School, have examined the dissertation entitled

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TABLE OF CONTENTS

WOMEN'S EXPERIENCES IN UNDERGRADUATE

ENGINEERING PROGRAMS IN JAPAN

AS RESOURCES TO THE DECISIONS TO PURSUE MASTER'S DEGREES

Masako Hosaka

Dr. Jeni Hart, Dissertation Supervisor

ABSTRACT

The purpose of this qualitative study is to describe how women engineering students in Japan experience engineering study and how their decisions to pursue a master's degree are informed by their experiences. The study is framed by identity (control) theory (Burke, 1991; Stryker, 1968, 1980). This research draws upon interviews with 32 final-year undergraduate women students in two different national engineering schools in Japan. The findings indicated that these women engineering students perceived their study and engineering identity were constrained by poor teaching and little guidance from the faculty since early stages in their program. They also experienced challenges in participating in group work because of token status. As a result, they were inclined to have low evaluations of themselves as future engineers. Sense of social isolation, powerlessness, constraint, and inadequacy prevailed. Despite these experiences, those who planned to pursue master's degrees tended to engage in engineering-related activities relatively actively and interpret their experiences more positively. Implications for future research and institutional and departmental practices are provided.

Chapter 1

OVERVIEW

Introduction

Educational attainment and persistence is one of the most consequential outcomes in an individual's personal and public life. However, persistence in graduate education has not attracted as much attention from higher education researchers as has the persistence or graduation of college students (Pascarella & Terenzini, 2005). Gender inequality in postgraduate educational attainment has been almost ignored as a research topic, likely because absolute numbers indicate that more women than men now enroll in graduate programs and obtain graduate degrees in the United States (National Center for Educational Statistics [NCES], 2008). However, when controlling various factors (e.g., parental education, academic performance), women are still less likely to enroll in graduate programs than men, except at the master's level (e.g., Millette, 2003; Mullen, Goyette & Soares, 2003; Perna, 2004) and have always been underrepresented in certain areas of higher prestige, including engineering (NCES). Because it is almost requisite to have an advanced degree to obtain professional jobs in the United States, it has become more important to understand factors that systematically create a gender gap at this level of educational attainment.

The issue of women's lower postgraduate educational participation is generally more serious in the counties where people have less gender-egalitarian social norms (Charles & Bradley, 2002). In Japan, women's educational attainment has historically lagged behind that of men's (Amano, 1997) under a Confucian perspective that places women lower than men in the social order. Japanese parents have traditionally invested

more in their sons than in their daughters because of the higher return expected for men than women in the sex-discriminatory labor market (Brinton, 1988; Ono, 2004). Until recently, women who enrolled in colleges tended to come from middle-class families and they were overrepresented in 2-year colleges and in feminine majors such as literature and home economics (Amano, 1997; Fujimura-Fanselow, 1985). As the population's general level of education has increased along with the gender egalitarianism, more than half of female high school graduates now directly go on to some types of postsecondary education institution and about 40% of 4-year college students are women (Ministry of Education, Culture, Sports, Science and Technology [MEXT], 2008). Still, women are less likely than men to pursue graduate degrees immediately after obtaining a bachelor's degree in Japan; while 15.4% of male college graduates immediately went on to master's degree programs, only 7.7% of female counterparts did the same in 2007 (MEXT, 2008). Women's lower participation in graduate education indicates that Japanese women forgo an opportunity to obtain high prestige jobs that require advanced degrees.

Engineering is one of the vocationally-oriented fields in which individuals are professionally trained in college for work in respective specialties. In Japan, where master's degree programs admit individuals without work experience, the number of master's students in engineering has greatly increased since the late 1980s when major manufacturing corporations started hiring graduates from master's degree programs actively (Nakayama & Low, 1997). Since then, the MEXT, which had authority to determine degree types and the enrollment size of universities, has strategically established graduate programs in the national university sector, starting with eight elite universities (Kobayashi, 1989; Manmi, 2001). Now, all 46 national engineering schools

have master's degree programs to accommodate demands. In 2007, almost one-third (31.8%) of 93,144 engineering graduates from all 4-year Japanese institutions went on to master's degree programs. Among graduates from national universities, the proportion is much higher: 62% for men and 44% for women (MEXT, 2008).

As is the case in many countries, women are a small minority in engineering in Japan. Although the number of women who major in engineering tripled between 1990 and 2004 (Kawano, 2007), only 11% of undergraduate engineering students are women in Japan (MEXT, 2008), compared to 20 % in the United States (NCES, 2008). The national data also show that women leave the field with a bachelor's degree at a higher rate than men. A smaller proportion of women than men obtain professional/technical positions immediately after graduation or go on to master's degree programs, which greatly increases the odds of obtaining professional jobs in technology-related fields (MEXT, 2008). Although engineering is one of the fields in which a high proportion of women graduates pursue master's degrees, the gender gap in persistence, both in the form of enrollment in graduate programs and job placement, is apparent at least in the national university sector (MEXT, 2008).

In this study, I explore the role of college experiences in individual's professional aspirations by comparing two groups of Japanese women in two national engineering schools who enter college well-prepared but make different postgraduate choices. In the following sections, after introducing the Japanese context, I will explain why this study is needed and how this study is conducted. Although researchers should be cautious about applying theories and findings developed in the United States to the Japanese context, this study mainly used the U.S. literature to understand Japanese

college students' aspirations because of the limited literature in Japan. At the same time, my study will inform U.S. studies about college students' aspirations for graduate education and enrollment in graduate programs.

Japan's educational system, in which all high school graduates are eligible for pursuing postsecondary education, is as open as its counterpart in the United States (Buchmann & Dalton, 2002). Still, the two countries differ in terms of the flexibility individuals have in choosing a major and options for graduate programs. College students in Japan have fewer opportunities to change their major once they enter college and, due to the research unit system and institutional hierarchy, they are likely to attend a graduate program in the same department where they obtained a bachelor's degree. Thus, students' attrition from engineering takes a different form in Japan than in the United States; individuals have a stronger incentive not to change their major and delay departure from the field until graduation to obtain a college degree. Despite these differences, college students' experiences are important to their postgraduate choices in both countries.

In the United States, educational researchers from different perspectives (e.g., sociological, econometric, socio-psychological) have developed a variety of conceptual models and identified factors that explain college students' aspirations for graduate education and enrollment in graduate programs in general (e.g., Carter, 1999; Hearn, 1987; Millette, 2003; Mullen et al., 2003; Pascarella, 1984; Pascarella, Wolniak, Pierson, & Flowers, 2004; Perna, 2004; Stolzenberg, 1994) and in Science, Technology, Engineering, and Mathematics (STEM) fields in particular (e.g., Leslie, McClure, & Oaxaca,1998; Malcom & Dowd, 2012; Sax, 2001). Past studies revealed that social structural factors such as individual family backgrounds and the characteristics of the

institution an individual attends (e.g., the selectivity, size, and control of the institution) constrain college graduates' enrollment in graduate programs (Millette, 2003; Mullen et al., 2003). In addition, social psychological factors such as students' initial educational and career aspirations, parental encouragement, and gender ideology influence college students' decisions (Hearn, 1987; Perna, 2004). The literature indicates that college experiences such as academic performance in college (Hearn, 1987; Millette, 2003; Mullen et al., 2003; Sax, 2001) and interactions with faculty and peers (Hearn, 1987) have some influence on individuals' decisions to pursue a graduate degree, although their influences are not as strong as structural or socio-psychological factors.

College students' aspirations for, or participation in, graduate education in Japan has not been studied as extensively as in the United States. Existing studies on educational attainment and participation in graduate education indicate that a lack of financial resources is an issue (Koinuma, 2009). According to studies that explain individuals' status attainment in Japan broadly, individuals' background factors, including family socio-economic background, academic performance in the ninth grade, and high school quality, determine their educational attainment (Yamamoto & Brinton, 2010). In addition, studies of Japanese women's life course have shown that individuals' gender ideology and their parental expectations are the two most important factors that form college women's career aspirations and attainment (Muramatsu, 2000).

Japanese Context

To better understand the rational for this study, I provide some background information regarding Japanese engineering students' collegiate experiences in their academic departments and their postgraduate decisions.

Engineering Students' Learning Environment in Japan

The learning environment of national engineering schools in Japan is characterized as follows. In a stratified and rigid higher education system, students generally graduate from the university with an initially declared major. It is not common to change a major or transfer to another institution because such a move usually requires individuals to take another college entrance examination. Individuals who enter engineering programs are thus destined to graduate with an engineering degree.

Engineering programs are typically structured such that undergraduate students progress as a cohort in 3 years and advance to the final year, when they exclusively engage in a senior research project. As students progress the year, they take more courses that involve hands-on activities. In the national university sector, all college students complete the senior research thesis project under faculty guidance in the research unit, an independent organization that consists of a professor, academic staff, graduate students, and upper-level undergraduate students (Arai, 1989; Chung, 1986). The senior research thesis project is considered a capstone course that prepares engineering students for future work in a highly specialized area and serves as preparation for master's level work for those who advance to master's degree programs.

Men predominantly populate engineering schools in Japan. The imbalance between men and women is much higher in engineering than in other STEM disciplines. With regard to engineering faculty, compared with the national average of 13% of all faculty, only 2% are women in engineering (National Institute of Science and Technology Policy, MEXT, 2012). Universities have made concerted efforts to increase the number of women faculty and staff since 2006. However, engineering is recognized

as the most challenging field to increase the number of women due to its small pool of qualified individuals (Gender Equality Bureau, Cabinet Office of Japan, 2012).

Postgraduate Decisions of Engineering Students

Readers should be informed of unique features of engineering students' postgraduate decision making in Japan. In short, engineering students face a strong expectation that they will pursue master's degrees in the same department where they pursue their bachelor's degree. Thus, undergraduate students in Japan need to evaluate their fit for the field and the department. Yet, at the point when students make decisions about pursuing graduate degrees, they are often not ready to assess their suitability for their field.

Engineering students in Japan need to decide their postgraduate paths at around the same time they enter the research unit. The third year when engineering students engage mostly in hands-on learning in the laboratory is a critical period to decide to pursue master's degrees. When entering a research unit at the beginning of the fourth-year, engineering students choose their engineering specialty, which determines the fields and types of job that they will pursue. Students who decide to work full-time after graduation typically start looking for jobs in the middle of the second semester of their third year and continue until at the beginning of the first semester of their fourth year when major firms finish recruiting prospective employees for the subsequent year (Kose, 2005).

Although the availability of professional/technical positions in engineering and related fields to college graduates fluctuates depending on the economy, employers have shown a strong preference for master's degree holders over those with bachelor's degrees.

An individual's chance of obtaining professional/technical positions, especially research positions in a manufacturing company, greatly increases with a master's degree (Nakayama, 2012). Nakayama's study shows that in 2010, whereas 60% of graduates from master's degree programs obtained jobs in the manufacturing industry (which indicates they would use their expertise in professional positions), fewer than 30% of graduates from bachelor's degree programs did so. This contrasts with 1990, when about 60% of those with a bachelor's degree found jobs in manufacturing. The lower proportion of graduates from undergraduate programs whose job is categorized as professional or technical indicates that engineering graduates often end up with jobs unrelated to their majors. In other words, it is unlikely that an individual who decides to enter the workforce upon graduation will remain in the field without a master's degree. Such a decision will hinder their pursuit of professional employment by reducing the odds of obtaining technical/professional positions. Even if students landed a job in technology-related fields, they will start at a lower-level position and their career progress will rest primarily in the hands of their employer.

In Japan, college graduates in the national university sector who go on to master's degree programs do not make a program choice because they are likely to enroll in the programs at the same department they graduate. The proportion of master's students who graduated from the same institution is higher in engineering than in other fields of specialty; more than 80% of first-year master's students in national engineering schools were the graduates of the same institution in 2007 (MEXT, 2008). It is not surprising that the admission rate of students who graduate from the same institution was

as twice high as that of those who graduate from other institutions in the national university sector (MEXT, 2008).

The close connection between undergraduate and master's degree programs is first due to hierarchy among institutions in the higher education system that promoted exclusiveness among institutions. Because of a program-specific entrance examination, it is easier for individuals who study in the program to prepare for the examination than others. Master's degree programs also exempt graduating students with an excellent grade point average from the entrance examination. Second, the research unit system that exposes students to a research community contributes to the thinking that continuing studying in the same research unit they studied in their fourth-year is more desirable.

Given the trend among engineering students in Japan to remain at the same institution for their master's degrees, undergraduate students are likely to develop a long-term commitment to the department through meaningful relationships with their peers and the faculty in the department. In addition to their interests in engineering as a field of study and professional career, a sense of membership in the community seems to be important to Japanese students' decision to pursue master's degrees. The first three years serve as the basis of students' commitment to master's-level education that leads to a professional career in engineering.

Problem Statement

Once entering the university, Japanese engineering students spend at least 3 years with the same group of similarly well-prepared individuals in their specialty, having little opportunity to explore other fields of study as their potential majors because of the inflexible educational system. Women are a small minority in engineering at the

undergraduate level. Those who do choose engineering as undergraduates are less likely than men to advance beyond a bachelor's degree program, despite the obvious benefits master's degree provides for equitable job opportunities. Although the low rate for women entering technology-related fields may have both supply- and demand-side causes, it is necessary to understand what motivates women to leave engineering by not pursuing master's degrees, which is a sure way to obtain a professional job in their field.

Purpose of the Study

The purpose of this study is to describe women's experiences in two different engineering schools and the roles of these experiences in their postgraduate decisions in Japan. Specifically, I intend to understand how women engineering students in Japan experience their engineering study in social interactions with others. I also intend to understand what women learn about themselves as engineering students or future engineers through their experiences in their major department and how women take the knowledge into consideration when they make their postgraduate decisions. The primary focus will be on determining whether and to what extent women's experiences discourage their pursuit of a master's degree.

From the perspective of symbolic interactionists' tradition, students' interactions with other members of the academic department, including through classroom learning, laboratory work, asking course-related questions, and discussing career issues are conceptualized as opportunities that students use to obtain information regarding the self as engineering students and future engineers. I will explore differences in the way women considered their experiences according to their postgraduate decisions.

Theoretical Framework

Identity (Control) Theory

I use identity theory (IT) and other relevant theories that have a structural symbolic interactionist tradition as a theoretical foundation for this study. This socio-psychological theory conceptualizes the self as having multiple identities organized in a hierarchy according to their importance. Under IT, the concept of identity refers to a role that connects individuals with the society in relationship with others (Stryker, 1968, 1980). It does not consider social identities such as gender or other personal identities. To develop an identity, individuals in a certain role (such as being an engineer) are expected to internalize the role through understanding of its meaning and engagement in relevant behaviors.

IT explains relationships between the strength of the identity, commitment to the identity, and behaviors. According to IT, an individual's choice of action is determined by the relative importance of a particular identity within the hierarchy of identities that an individual has (identity salience) and the strength of commitment to that identity. In other words, the more important the identity to which a certain action is related, and the stronger the commitment to that identity, the more likely the individual interacts with others in that identity and chooses that action. The concept of commitment, although slightly different explanations exist among sociologists, explains the social nature of identities that are based on a structurally constrained relationship with others (Burke & Reitzes, 1991; Stryker, 1968, 1980). According to Stryker (1968. 1980), commitment is defined as the sum of interactions and relationships with others that an individual in the role have. Interactional commitment refers to the number or scope of role relationships,

whereas affective commitment refers to the sense of belonging and attachment to others in role relationships.

In identity control theory (ICT), Burk (1991) explains the development of identity by using the metaphor of a feedback loop whereby individuals acquire identity through a cognitive comparative process. ICT incorporates both the identity standard that governs an individual's behaviors in the identity process and the role-based others (RBO) who provide feedback on an individual's identity performance in response to the output from the individual. In the process of identity development, individuals acquire feedback from role-based others regarding their performance or state of being in the identity, compare it with their own identity standards, and then choose a subsequent behavior (output) to reduce the gap between the two (state adjustment) (Burke, 1991). If the process is successful, an individual develops an identity. If not, an individual change the standard (Burke, 1991).

Role-based others play an important role in identity process. When the exchange between an individual and others who provide feedback fails, the identity process is interrupted (Burke, 1991). Burke cited other occasions of interruptions of identity process, including when an identity has conflicting identities. In the process of acting to fill the gap, the level of commitment to a certain identity, which reflects the strength of social tie that binds the individuals to that identity, determines the extent to which an individual considers the input. The extent individuals accept feedback from a certain role-based other depends on his or her importance. Individuals avoid conflict and develop the identity smoothly when they share the meanings of the identity with others; thus, accepting other's version of identity facilitates the process (Burke & Stets, 1999). Also,

individuals who have legitimacy in the identity has more power to influence on the interactional process (Burke, Stets, & Cerven, 2007).

In a feedback loop that considered identity development as the outcomes of exchanges of identity-related resources between individuals and their role-based others, their identity-related actions (output) move the process forward by creating more opportunities to receive feedback (input). The goal of their actions in the identity process is to become accepted socially in the community as individuals with this particular identity. Thus, taking an identity-related behavior that leads to subsequent identity-related actions and relationships with others is said to contribute to the acquisition and maintenance of identity by activating the feedback loop (Burke, 1991).

Application of the Framework

In the present study, the identity process at issue is that of Japanese women engineering students becoming academically and professionally successful in a manner that they are comfortable enough to consider themselves as future engineers and pursuing a career in engineering is a reasonable choice to them. Engineering students are expected to utilize ascribed resources and identity-relevant resources that they obtained through interactions with others in the department (e.g., faculty, peers) in their engagement in engineering-related behaviors, including their postgraduate decision.

This study focuses on the development of engineering identity. Although this study does not provide a definition of engineering identity, I assume that the engineering identity that women students possess should be regarded as a construct with multiple meanings that reflect the temporal and relational meanings. Through college education, students in engineering programs are expected to develop an engineering identity as

engineering students who, first of all, are academically successful enough to graduate, and then aspire to work professionally in engineering-related fields. They also need to have a sense of membership in their departmental community to claim an engineering identity.

Engineering students engage in behaviors that are related to engineering to achieve academic and professional goals as engineering students. Through engagement in identity-related behaviors, students are verified as engineering students and future engineers by others, develop and confirm their identity standard, and produce opportunities for further actions that are related to the identity. An individual's decisions regarding whether or not to engage in identity-related behaviors are largely based on the relative importance of the engineering identity (salience) and the strength of social and emotional ties with others in the department (commitment). In other words, the degree to which students have internalized an engineering identity governs their behaviors. Engineering students need to understand the shared meaning of being engineers (standard) at the department. Faculty is the primary individuals who offer such information, but other individuals in the department also offer information formally and informally.

Roles of Gender

IT explains that as a minority in engineering, women are disadvantaged in the following ways: women lack legitimacy as engineers, have limited opportunities to interact and form relationships with others in an engineering department, and thus are less likely to have their engineering identity activated in social interactions (Stets & Burke, 1996). However, there are also individual differences in women's engineering identity at

certain times depending on their career interests, preparation, and academic and social experiences in college. Furthermore, the relative importance of their engineering identity may be different in comparison with their gender-related identities (e.g., daughter, future wife) in the identity hierarchy.

Studies on women's experiences in engineering typically focus on gender at the individual level, gender identity, and examine how women manage or negotiate their gender identity in social interactions within the masculine nature of engineering culture (Hatmaker, 2013; McIlwee & Robinson, 1992; Powell, Bagilhole, & Dainty, 2009). This study that views gender as multilevel constructs (social, interactional, and individual) (Stetz & Burke, 1996) explores the influence of gender as a social structure on individuals' engineering-related behaviors and decisions, along with gender identity. In this study that primarily focuses on engineering identity, the issue women have is considered as one form of interruption in the identity process.

To reflect the focus of the role of gender as a social structure, I use expectation states theory (EST) to supplement I(C)T. EST, a structurally oriented socio-psychological theory, asserts that gender influences interactions between individuals in different social positions. EST posits that in goal-oriented settings, individuals use cultural beliefs about the status implications of their distinguishing characteristics, such as gender, race, and age, to organize their interactions (Berger, Fisek, Norman, & Zelditch, 1977; Carli, 1991; Ridgeway, 1993; Wagner & Berger, 1997). The theory states that status characteristics become salient in a setting wherein they either solely differentiate the actors or culturally link them to the task at hand. In a society where people consider men to be more competent than women for most tasks (Wagner & Berger, 1997), men tend to have an

advantage over women. Within a mixed-gender group, men are more likely to participate in the task-related activities, take leadership, and receive more lenient and favorable evaluation than women, especially when the group is skewed toward men and task is culturally linked to the men's work (Wagner & Berger, 1997).

EST was used by Ridgeway and her colleague (Ridgeway, 2009; Ridgeway & Smith-Lovin, 1999) to explain gender inequality among formal peers. Correll (2004) extended the use of the theory in non-group settings by demonstrating that individuals take biased views on tasks in association with their status characteristics. EST explains the phenomena that are applicable to women more broadly, where there are few individual differences. EST that explains individuals' participation in a task and evaluation of task performance will provide the additional means to link women's experiences in engineering with their gender.

Research Questions

In order to understand how Japanese women in 2 national engineering schools experience learning in engineering and decide their postgraduate decisions, I posed four research questions.

> Question 1: In their early final year—the time most engineering students decide their postgraduate plans—how do Japanese female undergraduate engineering students describe their engineering identity-related experiences? In other words, what did participants experience? What strategies did participants use in these interactions? What factors promoted or inhibited participants' identity-related behaviors?

Question 2: How did final-year Japanese female engineering students at 2 national engineering schools make sense of their experiences in the academic department in relation to their immediate postgraduate decisions and their future careers? Specifically, what information did participants obtain about themselves as engineers to support their fit or lack of fit for the field through interactions with others?

Question 3: In what way are Japanese female engineering students' departmental experiences and their understanding of those experiences different for those who go on to master's degree programs compared to those who seek immediate employment?

Question 4: In what ways did Japanese female engineering students consider departmental experiences in their postgraduate decisions relevant to becoming engineers?

Definition

The following definitions will be used in the study.

Chilly climate: A phenomenon in which women felt ignored in academic settings because they are in a minority.

Commitment: The sum of interactions and relationships with others that are only possible through the role identity (Stryker, 1980). Interactional commitment refers to the number or scope of role relationships, whereas affective commitment refers to the sense of belonging and attachment to others in role relationships.

Engineering Identity-related Behaviors: Behaviors in which engineering students engage to achieve academic and professional goals as engineering students. Academic activities

include classroom learning; laboratory work; learning outside the classroom, such as group study; practicum; undergraduate research; and academic advising. Career-related activities include individual and group career guidance, discussions on career-related issues, job search, internship, and preparation for graduate school applications. Through engagement in engineering identity-related behaviors, students are verified as engineering students by role-based others, develop and confirm their identity standard, and take further actions that are related to the identity.

Gender egalitarianism: The propensity for individuals to reject ascribed gender roles and to apply normative standards of equal opportunity in evaluating the fairness of gender distinctions in the public and private spheres (Charles & Bradley, 2002).

Identity process: Development and maintenance of an engineering identity. In the process, engineering students exchange identity-related resources with others within the department.

Identity Theory: A theory that conceptualizes the self as an entity that has multiple identities that relate to a specific role in the society (Stryker, 1980).

Master's degree programs: Any graduate programs that offer a master's degree upon completion of an undergraduate degree. In many national engineering schools in Japan, a master's degree is offered to those who complete the first 2 years of the doctoral program.

Membership group: A group of individuals with whom college students regularly interact.

National universities: Higher education institutions in Japan that are primarily funded by the national government under the supervision of the Ministry of Education, Culture,

Sports, Science and Technology. There are 87 national universities and colleges as of 2008, including 46 institutions that have an engineering school or programs (MEXT, 2008).

Postgraduate decision: A decision that engineering students make regarding their life after receiving a baccalaureate degree. Engineering students in Japan typically either go on to master's degree programs in engineering or seek full-time employment (MEXT, 2008).

Research unit: An independent unit within a department that has specific research areas. Research units consist of a professor, academic staff, graduate students, and upper-level undergraduate students (Arai, 1989; Chung, 1986). Engineering students become members of a certain research unit, typically at the beginning of their final year, and conduct a senior research project for a thesis under faculty guidance. The research unit system also exists in other fields of study in Japan.

Role-Based Others (RBO): Individuals who are in the role-relationships with the engineering student, including professors, staff, upper-class students, graduate students, and their classmates. They provide feedback on a student's identity performance.

Status characteristics: Cultural beliefs about the status implications of individuals' distinguishing characteristics, such as gender, race, and age. Engineering students used them in social interactions.

Significance

The theoretical significance of this study is that it will contribute to the development of the more generalized theory of college students' degree aspirations and educational attainment by conducting a study in a different context than in the United States. An examination of the topic in Japan that has a different educational and employment system seems to be especially beneficial, not to mention that Japanese cultures are usually defined as the opposite end of a collective-individual continuum (Triandis, 1989) as well as interdependent-independent continuum (Kitayama & Markus, 1994) with the American cultures. Thus, if similar themes emerge in the Japanese context to those in the United States, such themes would be extremely salient in theory development.

There are multiple points in terms of practical significance of this study. Policy makers in Japan may gain insights from the study regarding Japanese engineering women's postgraduate decisions in general. Findings regarding the roles that academic departments play in informing and influencing Japanese engineering women' postgraduate decisions will inform higher education leaders about possible changes to the curriculum, the physical environment, student services, and the organization at their institutions in order to improve undergraduate education and the advancement of women in the engineering profession.

This study may have implications for individual professors who are interested in improving their teaching practices as well as attitudes toward students. Engineering professors who were trained in the current educational system may not be able to recognize challenges and problems that some engineering women experience. Busy

professors may not be conscious enough of their roles in influencing students' college experience. I also expect that the research will be useful to practitioners in the United States. Practitioners may apply findings of the study to certain groups of international students and students from immigrant families, taking the context of this study into account.

In the next chapter, I will review the relevant literature in Japan and the United States in order to contextualize my study. In Chapter 3, I will explain the research method of the study in detail, including the interview procedure. Chapter 4 and 5 will present the study's findings and will discuss the meaning of them for policy, practice, theory, and future research.

Chapter 2

LITERATURE REVIEW

In this chapter, I review the literature on college students' aspirations for and participation in graduate education. The review has two parts according to the studies in Japan and the United States. Studies in the United States are mainly used. I do so with a concern that findings in the United States may not adequately reflect the Japanese context but do provide the most robust literature base.

Japan

In chapter one, I introduced the context that shapes the experiences of women in engineering programs in Japan. College students in Japan study with similarly well-prepared students. Pursuing master's degrees has become common among engineering graduates due to the demand from the private sector for individuals with research experience in a specialized area (Nakayama & Low, 1997). In addition to the credentialism, the consequences of a student's postgraduate choice seemed to be more complicated for women than for men, due to the gender-segregated and discriminatory employment practices in Japan (Brinton, 1989). Because there are only a limited number of studies on college students' degree aspirations and enrollment in graduate programs in Japan, I review studies of individual's educational and career aspirations and studies of women college students' experiences to inform my study.

Aspirations for and Participation in Graduate Education

To date, few studies have been conducted on Japanese college students' degree aspirations or enrollment in graduate programs. Little attention has been paid to the factors that explain individuals' educational aspirations. Educators might have assumed

that the selectivity of the institution the students attend, which reflects their academic preparation, explains their aspirations for graduate education or enrollment in graduate programs because traditionally, only elite universities in Japan had graduate programs that were mostly academically oriented.

Evidence from macro studies suggests that the socio-economic status of students' parents has some influence on college graduates' enrollment in master's degree programs in Japan (Hamanaka, 2002; Manmi, 1999, 2001). In a series of studies that evaluated the impact of the policy to increase the number of professional graduate programs in 1990s, Manmi (1999, 2001) examined the demographic change of graduate students at the master's level. By using a national dataset collected by the Japan Student Services Organization in 1990 and 1996, Manmi (2001) found that the proportion of disposable income that *Rikei* (fields of study that correspond with natural sciences and health sciences in the United States) students spent on books and study-related supplies had decreased over the years, and concluded that the proportion of students from middle- to high-income families had increased during this period, especially at elite national universities. This study shows that middle- to high income families are the group that benefited from the expansion of the graduate programs. In her previous study on master's students in social sciences and humanities in the 1980s and 1990s, Manmi (1999) found that the condition of the job market, which was measured by the proportion of new college graduates who obtained a job immediately after college and average first-year income of college graduates in each year, did not predict the proportion of female college graduates who directly went on to master's degree programs as much as it did the proportion of male counterparts. This study suggests that the middle-class tendency had

been existed among women at least in social sciences and humanities. These findings are no surprise because college education has been largely financed by students' parents in Japan (Japan Student Service Organization, 2010).

Some researchers examined women's aspirations for a graduate degree or factors that determined their decision to pursue graduate education. One study examined one fourth-year psychology student's perspective of pursuing a graduate degree (Matsuura, 2007). Another study studied gendered motivation for returning to graduate programs based on interviews with 12 middle-aged women (Ikematsu, 2011). The most relevant to my study is a study (Koinuma, 2009) that reports results of a survey of alumnae and current female students at a national engineering college (n=455). The study reported that for respondents in the undergraduate programs, the desire to start working and financial difficulties were cited as the two primary reasons for not pursuing advanced degrees. Lack of aptitudes was the first reason for respondents in the master's program for not pursuing master's degrees but only the fourth reason for undergraduates.

A study conducted at a faculty of letters (equivalent to college of humanities) in a selective national university informs that college students' initial aspirations for graduate studies may indicate uncertainty of their career plans. Miho, Okada, and Todoroki (2008) surveyed 525 newly admitted students to examine the relationship between first-year students' intention to enter the university and their career orientation. Researchers found that the proportion of students who planned to go on to a graduate program at the time of the entrance was the lowest among those who entered the university with a clear goal. Despite the differences of academic interests and career orientation between literature and engineering major students, this study indicates that

students with a definite career plan would not consider enrolling in graduate programs if their intended career did not require master's degrees. Studies reviewed here collectively suggest that financial resources have influence on college students' participation in graduate education.

Educational Aspirations and Attainment

Studies indicate that, in Japan, parents play an important role in women's educational and career aspirations and attainment than in men's through financial and psychological support. Studies of status attainment in Japan have revealed important factors that predict individuals' educational attainment: parental education, grades in the ninth grade, and the type of high school the individuals attends (Ojima, 2002; Ono, 2001, Yamamoto & Brinton, 2010). Grades in the ninth grade are important because students' academic performance in the last year of compulsory education determines what high school they attend. Parents play an essential role in individuals' educational attainment by investing in their children's education in the form of private schooling and supplementary education (Edwards & Pasquale, 2003; Stevenson & Baker, 1992). It is noteworthy that despite the society's changing gender egalitarian norms toward more egalitarian ones, parental investment behaviors have been unequal for boys and girls in Japan (Cabinet Office of Japan, 2002; Ono, 2004). For example, Ono (2004), using the 1995 Social Stratification and Mobility Survey (SSMS) that contain a national sample of adult of age 20 to 69, revealed that parents invest less in daughters, especially when they have male siblings. Parents hold higher expectations for their sons' education than for their daughters' education; for example, while 64.5% of father or 65.3% of mother expected their sons to receive some college education, only 40.6% of father and 46.5%

of mother expected their daughters to receive some college education. (Cabinet Office of Japan, 2002).

Until recently, most women in colleges have been from middle-class families and often pursued higher education as a means of personal enrichment (Amano, 1997). Current national data show that the average family income of female college students is higher than that of male counterparts at both undergraduate and master's degree level (Ministry of Education, Culture, Sports, Science and Technology [MEXT], 2004). Yamamoto and Brinton's (2010) recent study that used the 1995 SSMS supported this, too. They found that family assets and objectified cultural capital, which was measured by a composite index of a material ownership, predicted only women's higher education attendance. The evidence shows that family's financial resources mattered more to women than to men in terms of their educational attainment.

Previous studies also inform that women's educational aspirations and attainment are predicted by the gender role perception, which is developed in the family they grow up and social institutions they attend. The relationship between individual's education and gender role perception or gender ideology has been reported worldwide (Davis & Greenstein, 2009). The individual's gender-role perceptions, which are influenced by their parents' expectations and their mother's employment status, are often suggested to explain young women's career aspirations and attainment in Japan (Motoharu, 2004; Muramatsu, 2000). Studies on women's life course and young women's life course expectations support the claim that women with a traditional gender-role perception tended to have lower educational and career aspirations. In these studies, researchers take both women's career and family into consideration.

Researchers who examined intra-gender differentiation have pointed out that women's gender-role perceptions and other social norms are not the mere result of early socialization at home or the modeling effect of their parents. Researchers claimed that women also socially developed and maintained these norms at schools and in the educational system (Nakanishi, 1993; Yoshihara, 1998). For example, Nakanishi (1993) observed the corrective function of women's high schools by which girls developed different gender-role perceptions according to the school's distinct charter, ideology, and history. Girls in one high school that emphasized women's independence tended to develop more liberal gender-role perceptions than girls in the other high school that emphasized women's role as wives and mothers. Similarly, Yoshihara (1998) explained that women's tendency to avoid spending additional years after high school to prepare for the college entrance examination had been maintained societally because high school recommendations for admission to women's colleges preclude the need for an examination. However, by the use of this alternative means, it is likely the women will not pursue their first-choice college and instead choose to attend their second-choice, a decision that is likely to lead to less prestigious social positions. This practice is also more popular among graduates from privately funded girls' high schools than graduates from public coeducational high schools.

In summary, women's educational decisions are made within a social norm that devalues women's education. The studies cited above suggest that it may be problematic to assume that students' educational decisions are solely their voluntary choices based on preferences developed in the family. Rather, women's gender ideology is continuously developed throughout their education, and there is a route for those who make choices

according to traditional gender ideology. Women's pre-college educational experiences influence their educational and career aspirations. Studies that focused on individuals' educational choices suggest both social structural factors (educational institutions and family) and social psychological factors (parental encouragement and gender ideology) play a role in women's educational aspirations and attainment. Women who attend college are likely to have parents who have an unconventional view of women's education and have the financial means to support their child's college attendance.

Women's Experiences in College and Post-graduate Decisions

Only a limited number of studies have been conducted in Japan concerning women's experiences in engineering. Yet, these studies provide a glimpse of women's experiences in engineering schools (Kawano, 2007; Koinuma, 2009; Matsuura & Namie, 2002; Nagashima, Yagi, & Masuyama, 2000).

First, studies have reported women's perceptions of their engineering schools. For example, a survey of alumnae and current female students at an engineering college investigated the most frequently cited sources of dissatisfaction and reasons for not pursuing a further degree (Koinuma, 2009). The author reported that more than half of undergraduate respondents answered yes to the question that asked whether they were dissatisfied and/or uncertain in their study because they are women (Koinuma, 2009). One third of them chose "the uncertainty of future prospects" as the reason for their dissatisfaction. Among respondents who had already graduated from college, only 20% admitted that they were dissatisfied and uncertain in their study; the most frequently chosen reason for their dissatisfaction was "the gender-based special treatment by faculty and their peers." Another study examined fourth-year female engineering students'

perceptions of their school (Kawano, 2007). Two groups of women collectively reported that the research and the courses were the sources of attractiveness of their school. At the same time, they considered that increasing the number of female faculty members, along with improving facilities and student services, would be among the strategies to increase the attractiveness of the school to women.

Second, studies that inform engineering students' postgraduate paths have been conducted. Professors who chair the research unit have traditionally played an important role in students' job searches through their choice of their students for recommendation to a certain employer (Hirasawa & Hamanaka, 2008; Hirasawa, Sato, Yamaguchi, & Iwawaki, 2004; Nakayama, 2012; Nakayama & Low, 1997). For example, a study on job hunting and career attainment of engineering graduates, which used cross-sectional data of engineering graduates from undergraduate and master's degree programs in a selective university in Tokyo between 1965 and 1995, indicates the importance of the professor's evaluation on students in engineering (Hirasawa et al., 2004). The majority of engineering graduates relied on the professor who chaired their research unit for their job search. The researchers also found that engineering students who sought employment through the ties they developed in extracurricular activities, which has been a common strategy among students in other fields of study but not among engineering students, tended to have lower grades than average. The job market for engineering graduates has become increasingly more open and market-oriented (Hirasawa & Hamanaka, 2008; Kose, 2005) and firms rely on its own recruitment process in addition recommendations from the university. Although the role of professors has weakened due to the recent change, readers should not dismiss the professor's role because engineering students

conduct job search in a way that is more field-specific than other fields of study, which gave professors greater role in the process.

Reports on the on-campus career service and the survey results of women graduates' career (Cho et al., 2007; Uchida, 2011) inform the current status of women who graduate engineering programs. For example, using a national sample, Uchida reported that women exhibited lower rate of continuing their career than men among graduates from engineering technical colleges. More broadly, studies have reported the experience of deciding about post-college life and looking for a job. College women perceived it challenging to obtain women-specific information, such as women's work life in corporations and had less access to individuals who had an influence on hiring decisions during the job-searching period (Kariya, Okitsu, Yoshihara, Kondo, & Nakamura, 1992). According to a study that analyzed women college graduates' published essays on the experiences of job hunting, women learned for the first time in their lives that employers' expectations were different toward women and men (Yoshihara, 1995). Until they started looking for jobs, these women had been evaluated by their academic achievement. However, the women strategically used the gendered expectations of employers in order to obtain a desired job.

In summary, the studies that inform Japanese college students' postgraduate decisions are characterized as follows. Studies on Japanese college students' postgraduate decisions, including career aspirations and life course expectations, usually have not paid attention to the role that students' college experiences, including their academic performance or interactions with other individuals play in the decisions. Researchers have not focused on a specific population. Educational researchers seem to have taken it for

granted that whether individuals pursue master's degrees depends on the prestige of the institution. Because college students, who are responsible for their decisions as young adults, learn about their discipline and work in the field while they are in college, researchers should examine the role that college education plays in individuals' developing aspirations for graduate education. Women's construction of engineering identity occurs in a society where obtaining an advanced degree has become an increasingly popular option. College experiences are more important now because the education and employment markets have become more market-oriented.

Access to Graduate Education and Persistence in STEM Fields

In the following section, I will review studies in the United States that inform women's persistence in engineering in Japan that require master's degrees. Studies are mostly drawn from the literature on access to graduate education, both college students' aspirations for graduate education and college graduates' enrollment in graduate programs, and women's persistence in college and into a graduate level work in Science, Technology, Mathematics, and Engineering (STEM) fields. Although I acknowledge that women's experiences in engineering might be different from other STEM fields, I will not limit the scope of reviewed studies to ones that exclusively focused on women in engineering because much of the literature has explored the broader fields of STEM rather than a disaggregation (Blickenstaff, 2005; Seymour & Hewitt, 1997). Relevant studies of women's experience at a graduate level will be included.

In the first four sections, I review studies on students' experiences in college that have been studied as predictors of access to graduate education and persistence in STEM, including students' academic performance, interactions with faculty, peer relationships,

and the academic department. Higher education researchers have examined influence of college experiences on individuals' participation in graduate education although these factors have proven to be weak compared with other social and individual factors (e.g., institutional characteristics, family resources). In the last three sections, studies that exclusively deal with engineering identity, women's persistence in STEM fields after college, and macro-level studies on women's participation in STEM fields will be reviewed. In considering those studies, readers should be reminded that participants of this study, Japanese women engineering students, are academically well prepared when they enter the university and their departmental experiences take place in selective institutions that are situated in a less gender-egalitarian society.

Academic Performance

The grades that students receive in college, especially in their specialty areas, represent the degree to which students are or probably will be successful in their academic endeavor. To obtain a good college grade appears important for engineering students' decisions to pursue a graduate degree. Researchers have demonstrated that students' academic performance, usually measured by their cumulative grade point average (GPA), has a strong positive influence on their degree aspirations (Hearn, 1987; Pascarella, 1984) and enrollment in graduate programs (Ethington & Smart, 1986; Millette, 2003; Mullen, Goyette, & Soares, 2003; Stolzenberg, 1994; Wegner, 1969). Studies that focused on STEM fields also have shown that a grade is an important predictor of enrollment in graduate programs (Leslie, McClure, & Oaxaca, 1998; Sax, 2001). For example, Sax (2001) found that college grades and interactions with faculty positively predict both men and women's enrollment in graduate programs after

obtaining a bachelor's degree in science, mathematics, and engineering. Using two national datasets, the 1971 and 1980 Cooperative Institutional Research Program files and the 1979 National Longitudinal Survey of Youth, Leslie et al. (1998) showed that women benefit from having good grades. Among those who majored in physical science or engineering, the effect of having earned undergraduate grades of B or higher had a 50% greater effect on earning master's degrees for White women when compared with White men.

College students' grades predict their persistence in STEM fields (Brainard & Carlin, 1998; Crisp, Nora, & Taggart, 2009; Felder, Felder, Mauney, Hamrin, & Dietz, 1995; Jackson, Gardner, & Sullivan, 1993; Seymour & Hewitt, 1997). In a study involving students who earned a bachelor's degree at a Hispanic-serving doctoral-granting institution, Crisp et al. (2009) found that the likelihood of earning a STEM degree was uniquely associated with students' first-semester GPA along with other variables, including gender, ethnicity, SAT math score, and high school percentile.

These findings are not surprising considering that individuals need evidence of their good performance to develop academic confidence. The importance of obtaining a good GPA in women's persistence in STEM fields is supported by Seymoure and Hewitt (1997) who reported that women were more likely than men to cite grades as a contributing factor in their decision to leave science and engineering fields. However, there is evidence that a good GPA alone does not guarantee women's participation in graduate education or persistence in STEM as directly as men's. College women in STEM fields now enjoy higher GPAs than men (Sonnert & Fox, 2012). Yet, studies report that even women who enter the university well prepared and perform well have

become less confident about their abilities in engineering and exhibited lower self-efficacy in engineering than men (Brainard & Carlin, 1998; Felder et al., 1995; Soldner, Rowan-Kenyon, Inkelas, Garvey, & Robbins, 2012; Vogt, Hocevar, & Hagedorn, 2007).

For example, Felder and his colleagues (1995) examined gender differences in engineering students' academic performance and attitudes toward their education and themselves as engineering students longitudinally in a sequence of five chemical engineering courses at a public research university. Although women and men in the study had a similar backgrounds, women continued to be less confident about their academic preparation for the course they were taking, and significantly fewer women than men indicated they would be satisfied with their nothing less than A for their grades. Brainard and Carlin (1998), in their report of the intervention program that intended to support women's persistence in engineering and science programs at a research university, found that women's level of self-confidence as math and science students dropped significantly by the end of their first year. Only after junior year, women's confidence level increased. Although it is not clear whether the lower grade itself did lead to women's lower self-confidence, the study provides evidence that women as a group receive lower grades and present lower self-confidence than men especially in early years. Women in STEM programs need to receive a sufficiently strong evaluation to be confident enough to persist, due to lacking legitimacy in these male-typed fields of study (Correll, 2001).

A few studies in non-STEM fields also suggest that women may interpret their grades differently than men do as they relate them to their educational and career

decisions (Carroll & Brayfield, 2007; Fiorentine, 1987). The symbolic as well as evaluative meanings of grades seem to differ between men and women. For example, Carroll and Brayfield (2007), who interviewed 28 first-year law students at the beginning of their first and second semesters, reported only women cited their poor grades as reasons for lowering their career aspirations. In his examination of reasons why fewer women than men in premedical programs apply to a medical school, Fiorentine (1987) observed that women with cumulative GPAs between 3.50 and 4.00 were as likely as men to apply to medical school, whereas those with cumulative GPAs between 3.00 and 3.49 were much less likely to apply. His findings suggest that women interpret the meaning of grades in relation to applying to a medical school differently than men, except for those with the very high GPAs.

The studies reviewed above may provide some insight for an examination of Japanese female undergraduate students' understanding of their grades in relation to their postgraduate decisions. Past studies indicate that college students' academic performance plays a pivotal role in their pursuit of graduate education and persistence in STEM. There seems to be room for students' own interpretation of their grades as a sign of their aptitude in their intended field of study. Women in STEM fields particularly need evidence that promote their confidence in the field, which has been traditionally considered as men's domain.

Interactions with Faculty

Faculty members within the major department are important contacts for engineering students, especially with regard to their preparation for an career in technology-related fields. Poor teaching practices and inadequate advising systems in the department are reported to concern students in science, engineering, and mathematics programs (Seymour & Hewitt, 1997). Thus, it is especially important to review what researchers know about the impact of college students' classroom experiences and interactions with faculty outside the class on their decisions to persist or advance to a graduate program. Guided by Sax, Bryant, and Harper (2005), who comprehensively examined gender differences in the impact of student-faculty interactions, this section is organized as follows: individual interactions and academic climate.

Individual Interactions with Professors

Researchers have generally concluded that college students' interactions with faculty outside the classroom have positive impact on their degree aspirations (Hearn, 1987; Kuh & Hu, 2001; Sax, 2001; Sax et al., 2005). For example, Sax et al. (2005) found that general faculty support that was measured by an aggregate of several survey items had an equally strong impact on men's and women's degree aspirations although women received a higher score than men. They also found that only women's degree aspirations were negatively affected by their perceptions that faculty did not take their comments seriously. With the students in science and engineering, by using the 1985 CIRP Freshman Survey and its follow-up surveys, Sax (2001) found that student-faculty interactions, which were measured by the same items she used in a study in 2005, had a positive influence on college graduates' enrollment in graduate programs.

Although the causal relationship is unclear, the relationship between student-faculty interactions and students' aspirations is not surprising, considering that the frequency of student-faculty interactions predicts other educational outcomes, including students' academic performance (Cole, 2010; Kuh & Hu, 2001) and self-concepts (Vogt et al., 2007). In addition, Kim and Sax (2011) found that the relationship between general faculty contact and cognitive skill development tended to be greater in academic majors with higher levels of positive faculty support, suggesting the important role faculty can play in student learning. However, the challenges seem to be that college students are not positive about interacting with faculty outside the classroom and actually had negative experiences. One qualitative study reported the perspectives of students on the student-faculty interactions that rarely happen (Cotton & Wilson, 2006). They found that undergraduate students, partly from their ignorance of faculty's work, did not understand the benefit of contacting with faculty and avoided extra work. Also, some studies reported that students do not necessarily benefit from direct contacts with faculty (Sax, 1994; Kim & Sax, 2011).

In the STEM fields where women are scarce, researchers have shown that women benefit from receiving encouragement from faculty for persisting and forming higher educational aspirations (Rayman & Brett, 1995; Sax, 2001; Zeldin & Pajares, 2000). For example, in their study of women who graduated from a selective women's college with either a science and mathematics degree from 1983 to 1991, Rayman and Brett (1995) found that the odds of remaining in the field 6 months after college graduation were 3.6 times greater for those who received career advice from their faculty advisor and 1.9 times greater for those who received career advice from any professors

than those who did not. Ironically, women were typically had more difficult time to approach faculty in STEM (Baker Tancred, & Whiteside, 2002; Seymour & Hewitt, 1997).

Furthermore, higher education researchers in the United States have examined the impact of participation in undergraduate research programs, which are often designed to promote the pursuit of scientific careers, on degree aspirations or enrollment in graduate programs (Bauer & Bennett, 2003; Hathaway, Nagda, & Gregerman, 2002; Hunter, Laursen, & Seymour, 2007). These studies found that participation in undergraduate research programs had a positive influence on students' educational aspirations (Bauer & Bennett, 2003; Hathaway et al., 2002; Hunter et al., 2007) and that those who persisted in sciences after graduating from college tended to have research experience (Rayman & Brett, 1995). For example, in an assessment of college alumni's perceptions regarding their undergraduate research experience at a research extensive university, Bauer and Bennett (2003) found that participants in undergraduate research programs were twice as likely to pursue a doctoral degree as were those without research experiences. Program participants also tended to report significantly greater overall satisfaction and gains in their skills and abilities during baccalaureate studies. Sax and her colleagues (2005) reported that women undergraduates who had opportunities to do research with faculty are likely to show more interests in scientific research career.

Most studies on this topic have limitation to explain what role faculty play in the process or whether students develop interests in research through the program (Guterman, 2007). The only exception is Hunter and her colleagues' (2007) qualitative study. They reported on participants' perceptions of the aspects of their undergraduate research

experience that contributed to clarification or confirmation of their career plans, including going to graduate school. Interviewed students reported that participation in research programs gave them instrumental benefits such as knowing people in the field and being able to write about their experiences on a resume but did not boost their interests in the field.

Academic Climate

Higher education researchers hardly measure the influence of classroom climate or teaching practices on college students' degree aspiration. One such study that used data from the National Study of Student Learning (NSSL) reported that effective teaching practice enhanced White and African American students' plan for a graduate degree in their third year (Pascarella, Wolniak, Pierson, & Flowers, 2004). Another study (Colbeck, Cabrera, & Terenzini, 2001), using a national sample, examined how undergraduate engineering students' perceptions of teaching practices and classroom climate were related to their academic and career self-perceptions. The researchers found that both faculty impact on the classroom climate and teaching practices – namely, cooperative learning, clear and organized classes, and instructor interaction and feedback – positively related to changes in students' motivation to become engineers (Colbeck et al., 2001). In order to understand how women in engineering experience formal learning environments, studies that examined college students' perceptions of the classroom environment and teaching practices seem to be informative. In this section, I will review studies on chilly climate and teaching practices.

Classroom climate has been the concern of many educators since Hall and Sandler's (1982) study that reported women in college felt ignored and perceived

educational environments dominated by men to be hostile. Researchers have examined the chilly classroom for women with mixed result (e.g., Allan & Madden, 2006; Constantinople, Cornelius, & Gray, 1988; Heller, Puff, & Mills, 1985; Whitt, Edison, Pascarella, Nora, & Terenzini, 1999). Allan and Madden (2006) asked undergraduate women at a single research university about their confirming and disconfirming experiences of the chilly classroom for women. Twenty-five percent of women who responded to the survey reported they had experienced one of the 35 examples of chilly behaviors. Women in group interviews shared their experiences of feeling discouraged and invisible and of having their competence questioned. By comparing quantitative and qualitative research methods, Allan and Madden also demonstrated that chilly climate is a subjective perception and a sensitive construct to measure, reflecting researchers' framework and research methods. Researchers have reported women's perceptions of classroom climate and teaching practices in STEM, sometimes in relation to their intention to persist. Although the experience of overt discrimination is no longer being observed, studies in the STEM fields have reported that women perceive a classroom climate chillier than men do (Amelink & Creamer, 2010; Colbeck et al., 2001; Gallaher & Pearson, 2000; Seymour & Hewitt, 1997; Vogt et al., 2007).

Although not all existing studies, especially quantitative studies, support its existence, researchers have identified individual and environmental factors that influence students' perception of a unfriendly climate. College students' gender, personality type, and in-class participation level are responsible for their perceptions of the classroom (Cornelius, Gray, & Constantinople, 1990; Crombie, Pyke, Silberthorn, Jones, & Piccinin, 2003; Salter & Persaud, 2003). Cornelius et al. (1990) reported females are more reactive

to factors in the classroom that influence student participation, such as class size and gender composition. Crombie et al. (2003) observed that those who actively participate in the classroom, generally men, perceive the instructor more positively than those who do not and the interaction with male instructors gave women students the least overall impression. Environmental factors, such as the gender composition of the class, also affect students' perceptions. For example, based on the survey at a single institution, Serex and Townsend (1999) reported that both men and women who majored in male-dominated fields (accounting and engineering) were more likely to report chilly practices in the classrooms in their majors than those who majored in female-dominated fields (nursing and education). Some researchers explained that gender composition affects students' perceptions because it changes instructor's behaviors. For example, Canada and Pringle (1995) reported that when the proportion of male students increased, stylistic changes in professors' behaviors occurred, including an increase in follow-ups with male students and a decrease in follow-ups with female students. Similarly, Tatum, Schwartz, Schimmoeller, and Perry (2013), observing first-year students in 14 interdisciplinary seminar classes at a small, private, liberal arts college that had recently undergone a transition to being a coeducational institution, reported that as the number of men in the classroom increased, instructors' praise to students fell significantly.

Women's perception of a chilly climate or negative classroom experiences is problematic because they negatively affect students' self-perceptions and academic behaviors. Past studies have reported that classroom teaching and faculty's attitudes and behaviors in the classroom are related to students' self-perceptions. On the one hand, the unreasonably fast pace of the class negatively affects students' level of confidence

(Fassinger, 1995) and perceived discrimination had the strongest relationship to students' academic self-confidence and self-efficacy in engineering (Vogt et al., 2007). On the other hand, faculty's respectful attitudes facilitate college students' positive academic self-concepts (Komarraju, Musulkin, & Bhattacharya, 2010) and perceived math ability and degree aspirations (Sax et al., 2005). Komarraju et al. (2010), who examined the influence of multiple dimensions of student-faculty interactions, also reported that their experience of respectful interactions explains college students' intrinsic and extrinsic academic motivation.

In addition, students' classroom experiences affect their engagement in academic behaviors, including interactions with faculty outside classrooms. For example, based on focus group interviews of undergraduates at a mid-sized public research university, Cotten and Wilson (2006) identified factors that hinder interactions, including faculty attitudes and personality they observed in classroom. Wilson, Wood, and Gaff (1974) called this phenomenon "accessibility cues." They found that an instructor's willingness to solicit the views of students in class, to discuss a variety of points of view, and to allow students to express their ideas through essay exams and paper assignments is positively related to the extent of a teacher's out-of-class interaction with students.

In STEM fields, good classroom experiences with faculty have positive effects on college students, too. Especially, women consider personal aspects of professors important to their leaning. For example, feeling that faculty care about student learning was positively correlated with engineering students' satisfaction with the program as well as their long-term career aspirations in engineering (Amelink & Creamer, 2010). Women and men have different preference in teaching practices. When engineering

students at a research university were asked about the meaning of engagement in classes, women cited faculty's interests in teaching content and students, whereas men cited active participation (Heller, Beil, Dam, & Haerum, 2010). Colbeck and her associates (2001) also found that confidence as students and as future professionals was associated with different teaching practices according to students' gender; whereas clarity and organization were associated with gains in women's confidence, instructor interaction and feedback were associated with gains in men's confidence. Only collaborative learning was significantly and positively associated with gains in confidence for both men and women. Thus, the authors concluded that some women students are likely to face constant challenges in developing confidence and to perceive the classroom climate as unwelcoming if faculty uses only one teaching style.

Peer Relationships

The influence of peers on college students' educational outcomes has been of interest to higher education researchers. Although research has consistently indicated that peers have a great influence on college students' persistence and other educational outcomes, including their initial adjustment and academic performance (Astin, 1977; Pascarella & Terenzini, 2005), higher education researchers have not thoroughly studied peer influences on college students' degree aspirations (antonio, 2004). In science, technology, engineering, and mathematics (STEM) fields, the role of peers in students' persistence or degree aspirations has been examined as part of the department culture or social supports. To supplement our knowledge on this topic, it is necessary to review studies that examined the roles peers play in college students' academic and

non-academic experiences, in particular those that pertain to their aptitudes in the field and postgraduate decision-making.

Influence of Peer Groups on Degree Aspirations

Weidman (1989), who considered that peers contribute to the development of the informal social environment of college students, listed three types of peer influence: immediate interpersonal environment, membership group, and the institution. In the sociological literature on college students' degree aspirations, peer influences have been studied mainly at the institutional level as part of the educational environment that students in the institution provide in an aggregate form. This echoes the finding of an extensive review of studies on the educational impact of college in the 1990s: attending a small, private, selective institution generally had a positive influence on students' degree aspirations and attainment (Pascarella & Terenzini, 2005). Beyond these institutional characteristics, institution's peer culture seems to matter. For example, Pascarella (1984) found in his national study that academic or intellectual competition, which had a significantly positive influence on men's degree aspirations at selective institutions, did not influence women's aspirations. However, attendance at institutions where students overemphasize social activities and competitive sports had a direct, negative influence on women's levels of degree aspiration.

Existing studies have also indicated that characteristics of college students' membership group or the people with whom they interact play a role in forming their educational aspirations. However, few studies have investigated this topic due to the difficult research method needed to identify college students' friendship groups (antonio, 2004). In his study of first-year male students' degree aspirations at a highly selective

liberal arts college, Wallace (1965) found that changes in the students' graduate school aspirations over a year were directly related to the specific aspiration climates that prevailed among their senior peers with whom they had contact. In a study conducted 4 decades later at a highly selective public university, antonio (2004) examined the impact of immediate interpersonal environment, in terms of intellectual self-confidence, degree aspiration, and racial diversity of the students' friendship group, on third-year students' intellectual self-confidence and degree aspirations. He found that White students' educational aspirations were associated with the levels of self-confidence in their friendship group, whereas African-American students' educational aspirations were not associated, suggesting that the influences of college students' membership groups may not hold across different racial groups in the United States.

Peer Relationships and Culture in Engineering

The peer environment and relationships have been reported to be important to women's persistence in STEM programs, although few studies have used the characteristics of membership groups as predictors of students' educational or career aspirations in STEM. The peer group's orientation toward science at the institutional level had a positive effect on enrollment in graduate programs within 9 years for both male and female graduates of science and engineering (Sax, 2001). The effects were more than twice as strong for women as for men.

Researchers have been interested in understanding what information peers in students' major fields offer regarding their identity and work as future professionals. Based on an online survey and interviews of engineering students at 9 institutions, Amelink and Creamer (2010) found that relationships with other engineering students are

more important to women than to men for their engineering career aspirations as well as their satisfaction with the degree program. Vogt et al. (2007) found that the perception that male peers did not respect them as equals influenced women's academic confidence and self-efficacy in engineering.

Studies on women's persistence and socialization in STEM support the importance of peers. In a case study that compared women seniors who intended to persist in the fields of science and engineering after college with those who did not, Hughes (2011) found that only the former were able to identify with the peer culture and found someone supportive within their program, although the women in both groups shared perceptions that the masculine engineering culture was challenging. She asked about the women's life history regarding their career choices and their future plans after graduation twice, in the summer of their third year and the spring of their fourth year. Those who are in the nurturing environment specifically designed for women in STEM seem to benefit from the environment. Using data from the 2004-2007 National Study of Living Learning Programs, Szelényi and Inkelas (2011) found that women's participation in women-only STEM living-learning programs in their first year was positively related to their aspiration for graduate education during their fourth-year compared with women in other types of residential settings. According to them, women's perceptions that their residence hall was socially supportive were positively related to their plans to pursue graduate degrees.

Studies on women in STEM at more advanced career stages (Stage & Maple, 1996; Zeldin & Pajares, 2000), as well as students in STEM fields in general (Le & Gardner, 2010; McGee & Martin, 2011), also support the importance of peer

relationships. Professional women in Zeldin and Pajares's (2000) study formed supporting relationships within their department and tolerated the hostility from some of their peers. Presenting a different perspective, based on interviews with seven women who had successfully completed an undergraduate program in mathematics but had left the field and were pursuing a graduate degree in other fields, Stage and Maple (1996) reported that women cited discouraging experiences with their peers and social isolation as negative experiences in their undergraduate years.

Despite the evidence, some women in STEM do not seem to react to negative experiences much. Seymour and Hewitt (1997) observed that women in STEM were resistant to their negative experiences with peers. Colbeck and her colleagues (2001) did not find any statistically significant relationship between female engineering students' perception of differential treatment based on gender by male peers and self-perceptions as engineering students and future engineers, when other factors (teaching practices, students' pre-college characteristics, and perception of differential treatment based on gender by faculty and teaching practices) were controlled. They claimed this is because women in STEM have resilience. Capobianco's (2006) finding that some women considered their gender to be salient but others did not indicates that being a woman is not always a factor in whether an individual achieves an identity as an engineering student.

Interactions with Peers

Forming informal relationships. Past studies have reported that women in STEM face challenges in finding study partners and developing meaningful relationships within their department (Seymour & Hewitt, 1997; Tate & Linn, 2005). Having informal

relationships with peers in one's major field is important, as these relationships can lead to opportunities to engage in field-related activities and develop a sense of membership within the department. Although women in STEM fields now have strong academic performance (Sonnert & Fox, 2012), the literature indicates their experiences are not as smooth as their academic performance indicates. Studies of engineering students' learning have reported that although women are more likely than men to cooperate or seek help from others, they do not receive what they require and want. In other words, women in engineering suffer from the individualistic and competitive culture in engineering and have small social networks (Seymour& Hewitt, 1997; Stump, Hilpert, Husman, Chung, & Kim, 2011; Vogt et al., 2007).

Women need to have contact and relationships with male students because isolation from the mainstream has consequences in their engineering study, which requires cooperation to complete the work (Dryburg, 1999; Seymour & Hewitt, 1997). The more individuals women interact with, the more they obtain resources to tackle their workload. Furthermore, researchers and practitioners have reported the benefits of cooperative study in general (Johnson, Johnson, & Smith, 1998) and in engineering in particular (Hsiung, 2012; Stump et al., 2011). Research has reported the positive impact of academic interactions with peers on educational outcomes; that is, when students study with their peers, their engagement in learning activities increases (Cole, 2007; Cole & Espinoza, 2008; Lundberg, 2003). Ironically, however, in her study at an engineering school in South Africa, Case (2007) found that only students who were academically successful approached other students outside their membership group.

The difficulties faced by women when forming informal relationships can be explained in different ways. Because people tend to interact and make friends with others who are similar to them, generally along gender and racial lines (McPherson, Smith-Lovin, & Cook, 2001), it is not surprising that women's minority status within engineering departments constrains their choice of action involving others, especially minority women (Tate & Linn, 2005). Women are at least partially responsible for their social isolation. One study reported that undergraduate women in physics intentionally avoided working with male students in a group setting for fear of feeling threatened as engineering students (Hirshfield, 2010).

Working with peers formally in group settings. Formal learning settings provide women opportunities to form an idea of self as an engineer and to gain exposure to the engineering culture. Studies of engineering students' experiences in laboratory or other group work have found that women have negative experience of interactions with their male peers in terms of participation and recognition of their contributions (Allan & Madden, 2006; Du, 2006; Felder et al., 1995; Seymour & Hewitt, 1997; Swan, 2012; Tonso, 1996, 2006; Vogt et al., 2007). For example, a study that examined women undergraduates' experiences of chilly climate reported that women especially experienced an unfriendly climate in classroom discussions and group work where students interacted directly (Allan & Madden, 2006). Similarly, Felder et al. (1995) reported that women were more likely to be discouraged from participating in group work and perceived that their contributions to group work were often ignored, although they showed more willingness to engage in group work than men. Women's perceived challenges in group work settings might be due to micro-inequities between men and

women (Allan & Madden, 2006), However, their perceptions also occur in response to men's question about women's competence in engineering. Du (2006) observed that women's competencies in project work, such as managing and coordinating communications, did not seem to be identified as expected competencies and contributions in engineering practices at a Danish engineering university. Thus, competence that women demonstrate in academic settings, especially in direct interactions with others, may be downgraded by others as well as by themselves (Du, 2006).

In particular, working as the only woman in a group setting hinders women's learning opportunities (Allan & Madden, 2006; Colbeck, Campbell, & Bjorklund, 2000; Rosser, 1998; Tonso, 1996). For example, an ethnographic study of three groups at an engineering school reported that only in a team with three women could women's concerns regarding their attire be communicated; in a team with one woman, the woman was often ignored or ridiculed (Tonso, 1996). Women's constrained behaviors as the only female member in an interactive environment where students engage in male-primed tasks is not particularly surprising because it has been documented in experimental (Myaskovsky, Unikel, & Dew, 2005) and work settings (Hatmaker, 2012). Also, some researchers claimed gender differences in communication styles explain women's challenging experiences in group settings (Conefrey, 2000; Wolfe & Powell, 2009).

Sociologists explain that women's negative experiences in engineering work may be because of their status characteristics that indicate men's superiority in engineering over women (Ridgeway, 2009; Ridgeway & Smith-Lovin, 1999). Based on experiments in which college students were asked to perform a gender-neutral task and a

task that was associated with male skills, Correl (2004) found that the effect of students' gender on their emerging aspirations toward their future performance on the task differed with the gender belief associated with the task. The aspirations were different even when students themselves did not believe the existence of a gender difference regarding the performance.

Finally, past studies have reported positive outcomes of working with male students for women's development of engineering identity. In addition to gaining an understanding of the field and themselves as future engineers, female students have opportunities to work with their peers, which help them become acquainted with their peers and develop a motivation to study harder (Case, 2007; Du, 2006; Felder et al., 1995). For example, Du (2006) reported that women gained spiritual support by interacting with group members with whom they work. According to Case (2007), group work provided engineering students with good opportunities to be acquainted with their fellow students because they tended to interact with only a small number of students.

The Academic Department

Because this study examines what and how female engineering students learned about their postgraduate careers through interactions with other members of their department, I review studies that inform the influences of the academic department on college students' educational aspirations independently in this section. Sociological perspectives posit the department plays a pivotal role in college students' socialization in the field and life after college.

The role that students' major academic department plays in the academic and social aspects of undergraduates' socialization is emphasized in Weidman's (1989)

undergraduate socialization model. Weidman posited that a department is an important place of formal and informal interactions where students not only develop expertise in their field of study but also make career choice and develop values. College students interact formally with faculty and peers in the classroom and the laboratory and interact informally when students study together and ask questions of one another. A department can also be a place where students make friends with peers who are interested in the same major and who may influence their perspectives of their careers and life overall (Weidman, 1989).

In the higher education literature, the focus of studies on the academic department has shifted from socialization effects on graduate students to faculty-student interactions and connections to occupation and a stratification system (Hearn, 2007). In Japan, departments in engineering schools sort students into occupations with different levels of prestige and status in the sense that students pursue master's degrees at the same department in which they completed their undergraduate degree. The institution of higher education from which individuals graduate greatly affects their future social position in Japan. The department still plays a role to the extent that socialization in the department leads individuals to decide whether they should pursue master's degrees. National data indicate that master's degree holders have a better chance of obtaining a professional position than bachelor's degree holders (MEXT, 2008).

I found a few dated, but informative studies on the departmental influences on college students' postgraduate decisions. Hearn (1987) found that students' level of interaction with faculty in the department and satisfaction with the departmental faculty knowledge of the field predict their educational aspirations in their senior years along

with students' GPA, first year aspirations, masculine gender, and parental support of career plans. When examining gender-based interactions, only men's aspirations were positively affected by their satisfaction with faculty knowledge, and negatively affected by departmental student orientation. Men's aspirations depended more on academic factors whereas women's aspirations depended on the departmental climate that faculty created. It is also noteworthy that the level of faculty-student interaction, which was measured by the sum of three dummy items, including (a) chatted informally with a professor, (b) discussed career plans with a professor, and (c) discussed personal problems with a professor, depended not only on the size of the department but also students' grades in their first year, a finding echoed in Kuh and Hu's (2001) study that found interactions with faculty was determined by their grades and interactions with their peers.

Phelan (1979) found similar gender difference in his study that examined the impact of the major department on undergraduate students' value orientations toward scientific or scholarly careers. He found that in addition to students' initial orientation toward scientific or scholarly careers, interactions with major field professors and involvement in academic work had a positive impact on both male and female undergraduate students' orientations toward scientific or scholarly careers in their sophomore year. However, the independent effect of interactions with faculty on female students' orientations was far greater than that of academic involvement, whereas the pattern was reversed for male students (Phelan, 1979).

In the STEM fields, researchers have been slow to examine the role of the academic department in undergraduate students' degree aspirations or persistence,

although they are well aware of the role of the department as a place for socialization into the professional culture (Darisi, Davidson, Korabik, & Desmarais, 2010; Dryburgh, 1999; Hughes, 2011; Sallee, 2011). I will review two studies that compared students' experiences or outcomes by departments. Comparing experiences of female graduate students in two science departments (chemistry and biology) at one university, Ferreira (2003) reported different factors concerned female graduate students. In the biology department where women were relatively well represented, the competitive culture was no longer a threat as it was in the chemistry department. However, women had other concerns regarding life after graduate school, such as the difficulties of managing a career as women. Their awareness is acute because they did not see career options outside academia. Sonnert and Fox (2012) were interested in explaining the influence of the departmental environment in students' academic outcomes. Using national data, researchers investigated what departmental factors explain the gender gap in GPA in the department, which advantage women in recent years. They found that a higher proportion of women among the faculty and the existence of a departmental support program for women reduced the gender gap.

Women and Engineering Identity

Researchers have reported that engineering has a competitive, masculine culture; thus, women need to negotiate their gender identity in both educational (Dryburgh, 1999; Du, 2006; Powell, Bagilhole, & Dainty, 2009; Tonso, 2006) and work settings (Faulkner, 2009; Hatmaker, 2013; McIlwee & Robinson, 1992). The concept of identity has been used to understand women's persistence in engineering, although researchers have ascribed different meanings to the concept depending on their perspectives (Gecas, 1987;

Gee, 2000). In this section, I review studies that specifically deal with the identity of women in engineering and other relevant studies from both micro-interactionism and structural social interactionism to understand how individuals develop an identity, how they manage it in regard to other identities, and what influences the development of their identity.

Identity Conflicts between Gender and Engineering

Some studies have addressed the management of one's identity as an engineer that is in conflict with women's gender identity (Hatmaker, 2013; Powell et al., 2009). The authors typically have a dynamic perspective of gender and use West and Zimmerman's (1987) "doing gender" perspective, which is based on micro-interactionism. These researchers consider that identity is situational and individuals can manage their gender identity through performance. These studies are similar to the ones that deal with the socialization process of engineering students (Dryburgh, 1999; Sallee, 2011). The findings reveal that women constantly monitor their behaviors (how they present their gender or professional selves), often sacrificing the normal expression of their gender in the process.

For example, Powell et al., 2009 described various forms of gender performance that women undergraduates use to survive industry placements, including acting like one of the boys, accepting gender discrimination, achieving a reputation, advantages over disadvantages, and adapting an anti-woman approach. Through an ethnographic study of three groups in engineering at a public university, Tonso (2006) further explained that women's experience in engineering depends on the social identity of individuals involved in their interactions. Tonso (2006) reported that in addition to gender, students' social

identity, which reflects their membership in a cultural group on campus, plays a role in their experiences. She highlighted how two demographically indistinguishable women's teamwork experiences dramatically differed based on whether the group leader's social identity was defined as a *nerd* or an *overachiever*. She claimed that the social identity of engineering students was an extension of campus culture, and that influences on students' experiences depended on the students' position in the hierarchy of social identities on campus, which determines their relationships with others. In other words, the way in which group members interact and work depends on the social identities of the group members, especially that of the leader.

Meanings and Development of Engineering Identity

Other researchers who are more interested in the content of an engineering identity itself have examined what constitutes an engineering identity or what contributes to its development and maintenance. These researchers posit that identity develops or changes and they have a more stable view of identity. They have argued that women's experiences (e.g., the education they receive, the actions they take) are important in the sense that women interact with other individuals in their major department to develop their identity as engineering students and eventually as engineering professionals. These researchers suggest that being an engineer has multiple aspects (e.g., academic, social, future, institutional, gender) and explain individual differences as a compound of many factors rather than an issue of gender only. Social-psychological studies that examine the gap between an individual's STEM identity and other identities and the individual differences of an identity can be included in this group.

Capobianco (2006), using Holland's (1998) identity development and Gee's (2000) multiple identities as a framework, posited that an engineering identity has multiple identity facets and changes over time. Capobianco characterized the way women students view themselves as engineers as follows: academic identity, institutional identity, gendered identity, and role models. Her study is based on a longitudinal interview of four women undergraduate students. She asked the women what they thought of themselves as engineers (current and future engineering identity) and to describe experiences and events that they believed were important to them becoming engineers.

Tate and Linn (2005) similarly posited that an engineering identity comprises multiple identities and claimed that women minority students lived in two separate social worlds due to these multiple identities. Based on interviews with five women of color in engineering, Tate and Linn reported that these minority women developed academic peer groups apart from their social peer group, which were mostly from the same ethnic background. In engineering, women minority students faced difficulties finding study partners because they lacked opportunities to meet women of the same ethnicity within the department with whom they could easily identify. As engineering students, they were supported by friends outside their department. Tate and Linn's study indicates a dilemma of minority students who need to have more than one social world.

Du (2006) used the concept of community of practice (Lave & Wenger, 1991; Wenger, 1998) as a framework to describe how women engineering students were relegated to being peripheral learners and faced more challenges than men in becoming members of the engineering community. Examples include the following: taking a longer time to get used to the learning environment and having a sense of insecurity about being

different. However, the author also suggested some positive consequences of problem-based learning as settings that can provide spiritual support for women and opportunities to understand the scope of engineering work by participating in activities. Du chose the context of problem-based learning as the place where learning or formation of an engineering identity occurs. In her study, students' actions and interaction experiences are linked with the engineering identity.

Finally, using Stage Theory that assumes identity develop over years as their framework, Meyers, Ohlahd, Pawley, Silliman, and Smith (2012) quantifiably demonstrated the different levels of engineering identity among engineering students. Researchers asked engineering students in a private research university in the Midwest whether they had an engineering identity with a yes/no question and examined what factors contributed to the differences. Their findings that having an engineering career plan increased the odds of claiming an engineering identity indicates the relevance of having a career plan to the development of the engineering identity. Additionally, they found that being first-year students decrease the odds of claiming an engineering identity, which indicates that students' commitment to a particular field should be acknowledged earlier at educational institutions to facilitate the development of an identity. At many universities in the United States, including the study site, students do not have to declare their major until the end of the first year.

When studying identity in engineering, researchers need to consider all of the other individuals in the department, a group with whom students are expected to socialize. The issue of identity acquisition can be explained as socialization in an engineering culture (Dryburg, 1999). Researchers differently frame the gender of an individual.

Whereas some frame gender as an aspect of social identity that an individual needs to manage, others frame it as the social constraints that influence an individual's behaviors. In both perspectives, being a woman works against women in engineering. These studies collectively demonstrate the usefulness of the concept of identity to understand the process of becoming engineers.

Social psychological studies inform the relationships between persons' behaviors, commitment, and the salience of the identity. Some studies that examine the gap between an individual's STEM identity and other identities, including gender identity, to understand the development of STEM identity. These studies report that the smaller the gap, the more likely individuals develop their STEM identity (Lee, 1998; Rosenthal, London, Levy, & Lobel, 2011). Other studies examine the individual differences of identities to understand the effects of certain experiences (e.g., curriculum, intervention programs) (Collier, 2000; Lee, 2002). For example, Collier (2000) found college students who participated in capstone courses in a single university had advantages over those who did not participate with respect to acquiring a college student identity. Through a survey of high school students who participated in science, mathematics, and engineering (SME) summer programs, Lee (2002) examined the differences between girls' and boys' experiences in SME-related activities and SME identity processes and found that the strength of the girls' relationships premised on SME involvement was changed more readily than that of the boys.

Women's Persistence After College in STEM Fields

Compared with the body of research on women's persistence toward graduation, fewer studies in the United States have specifically examined women's persistence in

STEM fields at the graduate level (Seymour & Hewitt, 1997). Past studies have shown that individuals' college experiences (e.g., grades, interactions with faculty, peer relationships) play a role in their decision to leave STEM fields. In addition, differences between successfully obtaining a bachelor's degree and pursuing a career within the field have been documented (Baker et al., 2002; Kirkup & Keller, 1992). Existing studies on this topic deal with college students' aspirations for graduate studies or a professional career, persistence in the field immediately after graduation or enrollment in graduate programs (e.g., Baker et al., 2002; Hughes, 2011; Rayman & Brett, 1995; Sax, 2001; Szelényi & Inkelas, 2011).

On engineering students' aspirations for graduate education, Baker and her colleagues (2002) investigated postgraduate plans of academically strong fourth-year engineering students at a selective Canadian university by using data from interviews and a student survey that was based on the result of the interviews. Baker et al. found that women were significantly less likely than men to express interests in graduate studies and more likely to consider changing the field after receiving a degree. Women in their study were having difficulty in taking necessary actions to apply to graduate programs, including asking for recommendations from professors and obtaining information regarding the general process of graduate program application and funding opportunities. In addition, these female fourth-year students were more likely to report negative experiences (e.g., lower than expected grades, discouragement in course-related interactions with faculty) in their undergraduate years, which negatively influenced their initial aspirations for graduate education. Hughes (2011) conducted a study of narrative life histories of 26 women in one undergraduate engineering program to understand

differences between women who persisted engineering and those who did not. She concluded that factors commonly used to explain students' persistence in STEM fields (parental support and education level, precollege preparation, and ability to identify with the disciplinary culture) did not fully explain women's choices because women interpreted their experiences in college differently.

Rayman and Brett (1995) examined the short-term persistence of all graduates with a degree in science or mathematics from one leading women's college between 1983 and 1991. They observed several noticeable differences between graduates who persisted by working within the field or continuing their studies in graduate programs, and graduates who changed or left the field; the former were more likely to have undergraduate research experiences and receive encouragement in college and at home to pursue a career in science. Individual variations of the odds of leaving science within 6 months after graduation were explained by career advice from advisors and other faculty, along with the combined parental variable and the number of science courses taken.

Sax (2001) investigated national sample of science and engineering college graduates' enrollment in graduate programs in science, mathematics, and engineering fields by using the 1985 Cooperative Institutional Research Program (CIRP) Freshman Survey and its follow-up survey in 1989 and 1994. Unlike Baker et al. (2002), Sax did not find any gender differences in the likelihood of enrollment in science, mathematics, and engineering graduate programs among graduates from biological sciences and engineering in 1985 after nine years. While students' initial career aspirations, GPA in college, and interactions with faculty had strong effects for both men and women, the

effects of the peer group's orientation toward science was much greater for women than for men, indicating the importance of a strong educational environment for women.

Macro-level Studies on Women's Participation in STEM fields

Although research on women's persistence in STEM fields has been conducted primarily at the individual level, structural sociologists also have tried to identify social and cultural factors that explain women's underrepresentation in STEM fields in different societies (Barone, 2011; Charles & Bradley, 2002; Hanson, Schuab, & Bakerf, 1996; Ramirez & Wotipka, 2001). These studies conclude that factors reflecting people's perspectives of women's education and work in society may explain the level of women's participation in STEM fields better than factors indicating the economic and political state of the country.

For example, in their cross-national study of sex segregation in higher education, Charles and Bradley (2002) found that gender egalitarianism of the country explained the cross-national variability in gender distributions across postsecondary education fields along with the structural diversification of postsecondary education and female labor force participation. Gender egalitarianism of the country was measured by the propensity for individuals to reject ascribed gender roles and to apply normative standards of equal opportunity in evaluating the fairness of gender distinctions in the public and private spheres.

Ramirez and Wotipka (2001) could not find statistically significant effects of independent variables that measured the country's societal development and political orientations on women's participation in science and engineering sectors either in 1972 or in 1992. Women's participation in science and engineering sectors was only predicted by

men's expanded enrollments relative to their age cohorts and women's expanded enrollments in the non-science and non-engineering sectors. In their panel analysis, only women's expanded enrollments in the non-science and non-engineering sectors in 1972 positively influenced the level of participation in the science and engineering fields in 1992. This study seems to remind us that the increase in the number of women students in STEM fields needs the good representation of women as a group in higher education in general. These macro-level studies indicate that the situation is particularly difficult in Japan, where people are less gender-egalitarian than other countries, such as United States (Gender Equality Bureau, Cabinet Office of Japan, 2012).

Summary and Rational

Reviewed studies indicate that women's college experiences were important to their decisions to pursue master's degrees because they develop their perception of themselves as engineers through interactions with others. The limitations of past studies on college students' degree aspirations and enrollment in graduate programs seem to stem from the paradigms as well as methods that researchers have used. Those who are interested in individual status attainment or reproduction of inequality have examined influences of institutional and individual structural factors, often ignoring the influences of individuals' experiences in college. Higher education researchers have adequately paid attention to the influence of students' collegiate experiences on their postgraduate decisions. However, researchers have limited in their investigation by defining college influences as the characteristics of the environment or students' achievement. They have not explained in what way college students' academic and career decisions are formed throughout their college years more holistically. Also, they focused on the influence of

faculty, which seems to be the old paradigm of college education in which teachers and learners are separated. Most researchers also have overlooked that other individuals on campus with whom students interact may also inform students' postgraduate plans while helping them successfully internalize the norm of the field. The use of a few large national datasets, which are not specifically conducted for the purpose, may also hinder the researchers' ability to examine some important factors that explain students' degree aspirations and enrollment in graduate programs while producing generalizable findings.

It seems fruitful for researchers to conduct studies from different perspectives with different methods in order to expand our knowledge on this topic. Given the extant literature on women in STEM, qualitative investigation seems to be especially beneficial to examine unexamined questions that have been identified in the review. The influence of college may be conceptualized from a symbolic interactionist's perspective in which individuals make a certain decision based on the information they have obtained from their experiences with others in various forms. The influence of college also may be conceptualized from an organizational perspective in which individual members of the organization, regardless of their status, play roles in socializing undergraduate students (Mortiner & Simmons, 1978). In either perspective, individuals have a choice depending on their interests, preference, and personality. College students' postgraduate choice is the outcome of accumulation of experiences in college, especially in the department. Individual's experiences in social interactions with others not only "influence" their decision after college but also "have a consequence" to their subsequent academic engagement. At the same time, undergraduate students' postgraduate decision may still

be constrained and enhanced by broader social factors as well as factors within the organization.

In the following chapter, I will explain how my study was conducted in order to explore some of the questions identified above. After describing who the participants are, I will explain how data were collected and analyzed. Trustworthiness, ethical consideration, and other issues will be discussed subsequently.

Chapter 3

METHOD AND METHODOLOGY

The purpose of this study is to describe Japanese women engineering students' experiences in the department and experiences of making their postgraduate decisions primarily in relation to their experiences in the academic department. I assume that college students' experiences in the department inform them of the field of study and their aptitudes in the fields, forming their educational and career aspirations. It is also assumed that college students' experiences in the department are constrained by their position in the society, including gender, family backgrounds, and the institution they attend.

I selected a qualitative method that allows participants to articulate their experiences and interpretation in their words and voices due to its strength in accuracy of theory building (Fine & Elsbach, 2000). College experiences, such as grades and student-faculty interactions, have been included in theoretical models that explain an individual's aspirations for and actual participation in graduate education (e.g., Carter, 1999; Hearn, 1987; Millette, 2003; Mullen, Goyette, & Soares, 2003; Pascarella, 1984; Pascarella, Wolniak, Pierson, & Flowers, 2004; Perna, 2004; Stolzenberg, 1994). Yet, the influence of college experiences on college students' decisions has not been well theorized compared with that of social structural factors such as students' background and characteristics of the institution students attend. In addition, applying the U.S. models directly to Japan is not prudent, considering cultural and social differences between two countries (e.g., higher education system, student mobility) (Kerckhoff, 1995). For the

purpose of policy and practice and understanding women in engineering more deeply, learning about what women engineering students experience is critical.

For the presentation of my study, I used case study design (Stake, 1995; Yin, 2003), which is an established way of presenting studies regardless of perspectives or methods employed in the investigation (Hatch, 2002; Wolcott, 2001). The units of analysis of this study are final-year Japanese female engineering students who are embedded in the context of Japanese higher education broadly and respective academic programs specifically.

Although developing a general theory of women's postgraduate decision making or aspirations for graduate education is not a direct goal of this exploratory study, I used constant comparative method (Glaser & Strauss, 1967; Strauss & Corbin, 1998) as a research tool because of its rigorous and systematic method to analyze the data. The constant comparative method approach helps me contribute to the future development of theory by providing detailed description of different patterns among Japanese female students.

This qualitative study was conducted from the postpositivist paradigm. Postpositivists strive for approximations of reality, while acknowledging the limitation of individuals' ability to apprehend reality fully (Hatch, 2002). The role of a researcher in this paradigm is to collect and analyze the necessary data as accurately as possible (Hatch, 2002). The epistemology of the researcher does not matter to the postpositivists' study, but I state my positionality later in this section.

Participants were recruited from two modestly selective institutions to ensure the answerability of the research questions. I primarily collected data through individual

interviews. In order to understand the context in which participants studied and made their postgraduate decisions better, I also collected relevant documents directly from the schools and through the Internet, including institutional data, student handbooks, curriculum, and visual books. These data were only used to facilitate my understanding. Although I did not collect observational data on formal educational settings, I observed how engineering students interacted with one another informally in settings such as hallways, cafeteria, or library. I was exposed to the two engineering school as I spent several days on each campus. In addition, I came to know more about one of the institutions while I was analyzing the data through my work. I interacted with professors and students in an engineering school in various occasions.

Institutional Settings

Institutions students attend provide them with the context in which they perceive their aptitudes in their major field and expect what their career would be like. Individuals' career prospects are largely determined by the graduating institution in Japan, to a greater degree in engineering where the school has traditionally involved in the recruitment process. In addition to the contextual information regarding national universities in general, I briefly describe the institutional settings of the participants.

The engineering schools at two universities from where I recruited participants are part of a national doctoral-granting university, which is located in the capital of a different prefecture, municipal unit that is equivalent to a county in the United States. Both Central University and Western University (both pseudonyms) started as prefectural medical schools and became national universities that had comprehensive programs of study after the World War II when the new educational system was introduced. These

schools that confer doctoral degrees have a higher than average rate of graduate school attendance, reflecting the schools' selectivity. The proportions of female engineering graduates who continue immediately to master's degree programs (35.7% at Central and 37.7% at Western) were much lower than those of male engineering graduates at these institutions (61.1% at Central and 73.3% at Western).

Central University is located in a city of 700,000, 3 hour drive from the second largest city in Japan, Osaka. Central University admits more than 2,300 students in its undergraduate programs each year. Western University is located in a city of 730,000, which is much farther from Osaka or Tokyo, the capital of the country. Western University admits approximately 1,700 undergraduate students annually. Both universities were commuter institutions. Engineering schools at the two universities admit roughly 500 full-time students each year and share many important characteristics, including women's representation both as undergraduate students (12.0% at Central and 13.5% at Western) and faculty (1.0% at Central and 4.7% at Western).

Although both universities have similar characteristics under the MEXT's control, the institutional climate to support women might be slightly different at the time of study due to allocations of financial support for women (Gender Equality Bureau, Cabinet Office of Japan, 2012). Western University had been receiving funds to support women faculty and researchers since 2007. In fact, the university was one of the universities that started receiving funds in the second year of its implementation. Central University was awarded the funds in 2010.

Participants

Specifications of the Participant

Participants in this study were 32 female engineering students in their final year at two modestly selective national universities in Japan. These individuals are the information rich individuals who collectively manifest the phenomenon, or case, of interest of the study (Patton, 1990), which is that women in engineering who have recent educational experience and made postgraduate decisions. The base types of group (Grasser & Strauss, 1967), by which I intend to compare students' experiences in the department, are students who plan to work full-time immediately after college (Work) and students who plan to go on to master's degree programs (Degree). The identity theory informs the following assumptions. Although participants currently share the same social position as engineering students at modestly selective institutions, they were likely to have different positions in society according to their engineering identity. The strength of engineering identity may be on a continuum and sometimes has nothing to do with their actual postgraduate plan. Yet, only students whose engineering identity is strong enough would plan to pursue master's degrees.

To understand women's perceptions of their collegiate experiences and their role in their postgraduate decisions, I included only women students in this study to reduce any variability in the process and consideration of individuals' decisions. Gender differences in college experiences in engineering and postgraduate decision making have already been extensively reported. However, existing general models do not explain women's postgraduate decisions as fully as men's. Thus, including men's college experiences and postgraduate decision making for comparison or men's perceptions of

women's college experiences would unnecessarily complicate the study process. Although including men would have provided an additional perspective on the topic, it is outside the scope of this study.

Although studying women's experiences in a certain department would provide the concrete context, this study examines women's experiences at multiple departments housed in two similar institutions. I decided to recruit participants from multiple departments regardless of their specialty because it was difficult to recruit enough participants from one department, considering the underrepresentation of women in engineering.

Because this study examines women's decisions to pursue master's degrees in their respective fields of study, it did not focus on experiences in college in general but in their major department. The department that offers degree programs seems to be the central place where students construct their engineering identity, specifically as future engineers. Under the refined view of social structure that differentiates social structures into the three levels (proximate, intermediate, and large) (Merolla, Serpe, Stryker, & Schultz, 2012), the academic department in which students study is considered as the proximate social structure where students interact with others with whom they exchange resources instrumental to the development of engineering identity, including information regarding their performance in an engineering role.

Purposeful Sample

I used purposeful and theoretical sampling to recruit participants (Glaser & Strauss, 1967; Patton, 1990). First, I chose to recruit participants from a few modestly selective national engineering schools where both pursuing a master's degree and starting

work full-time immediately after college were viable options. By recruiting participants from more than one school, I tried to eliminate the possibility of unintended bias stemming from an institution-specific context (Yin, 2003). I intended to recruit as many female engineering students with similar future prospects after graduation as possible. In a Japanese society where individuals are sorted into different educational institutions by the examination score as they move through the educational system, college graduates' career prospects, at least at their entry into the job market, is largely determined by the hierarchical position of the higher education institution from which they graduate (Brinton, 1988; Ishida, Spilerman, & Su, 1997; Sakamoto & Powers, 1995). Recruiting participants from a diverse set of institutions was unnecessary because the purpose of this study was not to seek generalizability. Two modestly selective national engineering schools I selected have similar historical backgrounds and currently are the public flagship universities of their respective prefectures.

Criteria for Study Inclusion

Three criteria for participation were used to bound the study: ethnicity, age, and the college entry status. At the outset of the study, I decided on the first two. During the data collection phase, I decided to use the entry status into the college as the third selection criterion for participation. First, I restricted participation to individuals who grew up and were educated in Japan. International students were excluded partly because of the different options after college, along with other differences such as culture and prior schooling experiences. International students' postgraduate decisions would depend on the country where they look for a job. While international students who are interested

in working in Japan may have similar decision making processes, those who plan to return to a native country may not.

Second, I only recruited participants who entered the university within 2 years after graduating from high schools. This participant restriction by age was necessary because undergraduate experiences of adult students are likely to be different at least in the aspect of interactions with others in the department. In a Confucian society such as Japan, individuals' age determines their positions in social interactions. Younger individuals are expected to speak politely when they address older individuals, such as faculty or more advanced students. This restriction was not very limiting because 96.7% of first-year students in national engineering schools entered the university within 2 years after graduating from high schools (Ministry of Education, Culture, Sports, Science and Technology [MEXT], 2008).

After the data collection started, I decided to exclude data from one transfer student in the sample. Transfer from national two-year technical colleges that offer a 5-year programs starting from the 9th grade to 4-year engineering programs has been common (MEXT, 2008). I realized that the experiences of transfer students who enter the university 2 years later than others make their experiences less typical. The transfer student I interviewed lacked not only the experience of the first 2 years of coursework, but also a "cohort" with whom she studied for more than one year in the department because of her participation in a study-abroad program. Her transient experience at the university seemed too different from other students to justify including her in the final sample.

Recruitment

To recruit women students for the study, I first asked for permission from the deans of three national engineering schools, including the one in Central University. These three schools were all located in Western Japan. As soon as I obtained permission from one of the prospective participating schools, I obtained approval from the University of Missouri's Institutional Review Board (IRB), which enabled me to recruit participants. Because I only heard from Central University and had not heard from two other schools after a period of time, I contacted Western University. In the end, all four engineering schools gave me permission to recruit participants. Due to a small number of participants in other two universities (2 and 4, respectively), I decided not to interview students from these two universities for budgetary reason.

In the letter requesting permission from deans, I described the following: purpose of the study, the time frame of the study, the procedure of the study, the desired number of participants, possible benefits and risks to the participants as well as to the schools, my contact information, and the contact information of my advisor and the IRB (Appendix A: Letter for Permission). I informed my gatekeepers that I would like to recruit approximately 10-15 participants at each institution. I suggested three possible methods of soliciting students' participation, including: (a) sending out a mass recruitment e-mail to all final-year female students; (b) posting a copy of recruitment e-mail on a bulletin board for undergraduate students; and (c) asking department chairs to distribute recruitment copies of recruitment e-mail directly to female students through the research unit with which all final year students are affiliated. Because I was aware that university officials were concerned about protecting their students from outsiders, I

informed the deans that I was willing to follow the direction of the school as long as students' voluntary participation is ensured (Berg, 2001).

Upon my request, each school helped me recruit participants in different ways. At Central University, the dean introduced me to one of the professors in two departments that had the largest and the second largest numbers of women: bioengineering and applied chemistry, respectively. They assisted me in recruiting students by forwarding my e-mail. At Western University, the dean asked all department chairs to provide contact information of a certain number of women students according to the proportion of women students within the department. In the recruitment e-mail that I sent to the deans for distribution, I provided the following information: the purpose of the study, the targeted population, potential benefits of participation, the study period, the duration of the interview and meeting, the interview procedure, interview topics, the language used in the interviews (i.e., Japanese), and my contact information (Appendix B: Recruitment E-mail). In the recruitment e-mail, I informed potential participants that involvement in the study was voluntary and the content of the interview would not be published in a form that identified individuals. I also asked prospective participants to contact me directly if they were interested in participating in the study.

At Central University, interview dates were arranged separately for students from each department. Nine students from the bioengineering department contacted me directly via e-mail in response to the solicitation e-mail. Interviews dates with six students from the department of applied chemistry were arranged with a help of a professor who solicited participation for me. At Western University, an administrative staff member in the engineering school sent me a list of 20 prospective participants with

their names, contact e-mail addresses, and the major departments. After I contacted these prospective participants, 17 of them agreed to participate in the study. I scheduled the interview dates in the period of one week.

I sent an informed consent form that is written in Japanese in advance by e-mail (Appendix C: Informed Consent Form) so that students could decide whether they wanted to participate in the study before scheduling an interview. I gave priority to those who were willing to have their interviews recorded because it would enhance the accuracy of my data. All agreed to have their interviews recorded.

I interviewed students from Central University first. At Central University, six students planned to obtain a job and nine students planned to go on to master's degree programs. I wanted to recruit at least ten students from each group (Work and Degree) who planned to obtain a job after college and who planned to go on to master's degree programs. Because I had the desired number of students (i.e., number of participants by institution, department, and plans) from the initial recruitment efforts, I stopped recruiting students.

Characteristics of the Participants

All female students who volunteered were interviewed, including 19 students who planned to pursue master's degrees (9 from Central and 10 from Western) and 13 students who planned to start working full-time (6 from Central and 7 from Western). While Western participants (n=17) came from six departments (material science and chemistry, material engineering, architecture, civil engineering, mechanical engineering, information science and electronics engineering), Central participants (n=15) came from the two departments that had the largest and second largest proportion of women (applied

chemistry and bioengineering). Participants were all unmarried and of traditional college age, which is typical in the Japanese context. Almost all students graduated from co-educational public high schools.

Data Collection

I conducted interviews within a few months after the start of the academic year to ensure that students had a good idea of their past college experiences and postgraduate plans. It was June and July in 2009 because the academic year starts in April in Japan. I expected that whereas participants still remembered what coursework in their department was like, they had not been influenced by their recent experiences in research units at that time. I also expected that participants who were in their final year in the undergraduate program had already decided on their postgraduate plans by the time when major firms had completed their recruitment of prospective college graduates (Kose, 2005) and graduate programs had started the admission process.

If I investigated women's college experience or postgraduate decision making rather than both, I would have had other better options. I could have interviewed students in early years in their program of study to understand women's more current experience in the transitional stage. To explore postgraduate decisions, I could have interviewed recent graduates who had already enrolled in graduate programs or had started working. Yet, the design is fine because college students' plans are fairly definite by that time due to the fixed schedule by which major employers recruit prospective college graduates. Consequently, the focus of this study is the first three years when students take coursework, which is distinct from the final year when students engage in a capstone project in a research unit. The design eliminates unnecessary variability in the final year.

Interview dates were scheduled over 4 weeks, so that I had ample time for reflection between interviews. At each school, a classroom or meeting room was provided for interviews. This was beneficial considering the difficulty of finding a quiet, private location on or near campus. Participants, who worked in a research unit all day also seemed to benefit from the proximity of the interview site.

Interviews were conducted in Japanese, the native language of participants and me. Because the language plays an important role in developing a trusting, respectful relationship during the interview (Seidman, 2006), I paid careful attention to my language. In Japan, people's speech is strictly governed by the speaker's relative social status, which is determined by age, gender, and occupation, than in the United States. I shared the same gender and status as a student, but I was married and about 20 years older than the participants. It would be awkward for strangers with such a large age difference to talk frankly. In order to avoid possible hierarchical interactions due to the age difference, I tried to talk politely, in a manner that people use in business, but was also cautious to ensure that participants would not feel that the interview was too formal. In order to avoid unnecessary challenges, I did not reveal my background (e.g., marital status, age) in great detail unless students asked. In a 90 minute appointment, I conducted an in-depth, semi-structured interview with each participant for approximately 60 minutes. The appointment consisted of a pre-interview, interview, and post-interview.

Pre-interview

Before starting the interview, I explained informed consent and asked participants whether they understood the information (Appendix C: Informed Consent Form). Then, I

asked participants to sign the informed consent if they were willing to participate in the study. I provided students a second copy of the consent form for their records.

I expected that those who engaged in job searches had job interviews in which they tried to present themselves and their college experiences positively in order to impress interviewers. Nineteen participants, including six students who planned to go on to master's degree programs, recently had job interviews. I reminded the participants of the different nature of the interview for this study as compared to job interviews and encouraged them to be candid.

Interview

In order to understand each interviewee's backgrounds effectively, I asked background information before starting asking interview questions. This information included: college entry status (i.e., whether they entered college immediately after high school or not and whether they took an entrance examination or entered college through high school recommendation); characteristics of the high school they attended (e.g., public or private, co-educational or single sex, and the location [within the prefecture or not]); and family backgrounds (e.g., number of siblings, birth order, parents' education, parents' occupation [whether working in a technology-related field or not], and parents' employment status). I asked these questions as part of the interview instead of asking each participant to complete a demographic survey. This served as a good introduction to the interview. During the interview, I used the information to facilitate dialogue and further understand their backgrounds.

In each interview, I asked 10 open-ended questions (Appendix D: Interview Questions) and additional probing questions. Interview questions were developed based

on a review of the literature on college students' aspirations for graduate education, college graduates' participation in graduate education, as well as college students' persistence in the Science, Technology, Engineering, and Mathematics (STEM) fields. The questions were also informed by a pilot study, in which I interviewed 36 women engineering graduate students in Japan about their experiences deciding to pursue graduate education (Hosaka, 2009, 2010). In a Japanese culture where people are expected to assume the meaning from unspoken language, people tend not to articulate as concretely as Americans typically do. From my previous research experience, I learned that women in Japanese engineering schools tended not to be very talkative. Japanese women engineering students I interviewed for a pilot study did not seem to accustom to answering questions that ask them to describe their experiences. They seemed to assume that a listener understood their context without elaborating much. In order to obtain rich information of participants' experiences, multiple probing questions were prepared in advance for use and emerged during the interview.

After gathering demographic information, the interview consisted of three additional sections: an introduction, academic experiences in the major department, and the process of deciding postgraduate plans. At the beginning of the interview, I asked students to introduce themselves by sharing their college experiences in general and talking about their postgraduate plans and career goals. I encouraged students to talk about themselves as engineering students as much as possible in their own words.

Then, I asked participants about their academic experiences in the major department; in particular, I asked them to describe interactions with other individuals in the department, both in and outside classrooms. I first asked participants to explain their

social worlds in college broadly and identify individuals who are important to them as engineering students. I encouraged students to provide concrete details so that I could picture the scene as they were interacting with others. I inquired about who might be the other members of the department, including peers in the cohort, more advanced students, graduate students, staff, and faculty. When it was not clear, I asked participants to specify the gender of the individual to whom they were referring. I also provided examples of contexts where students might have interacted with others to prompt them to recall their interactions, such as classrooms, laboratories, library, cafeteria, hallways, and their own apartments. I tried to guide students without being directive to reflect on their experiences by providing these possible contexts. At the end of this section, I asked participants how they assessed their suitability for a career in technology-related fields in general, and their engineering specialty in particular, based on their experiences.

Lastly, I again asked participants about their experiences deciding whether to pursue master's degrees and what they expected to do for the rest of their undergraduate years and beyond. I specifically asked how participants chose a path after college; how they discussed these options with people in the department and significant others; and what constraints, if any, they might have experienced in the process. At the end of the interview, I asked participants to describe whether and how they perceived the role of their gender in their collegiate experiences and their decisions. I waited until at the end of the interview to ask this question because I wanted to see if gender would emerge as a salient factor for these women's experiences, before prompting the issue. I asked this question to all participants, including those who had already talked about the role of gender during the interview.

Post-interview

After completing the semi-structured protocol, I tried to confirm the accuracy of my understanding with participants. I made sure that I understood them well. To do so, I summarized what I had heard and asked participants whether my understanding was correct. I also asked participants to rate their intention to pursue master's degrees and other experiences by using a Likert scale response (from 1 to 5) (Appendix E: List of Topics Participants Rated). I used the information as member checking to confirm my understanding of the participants' statement on each topic. For example, I asked participants to rate the perceived degree with which they interacted with professors in the department. When I was comfortable that the participant had already made the issue clear in the interview, I did not ask them to rate.

Before concluding the meeting, I asked participants whether they had anything else to share with me regarding their experiences in college and postgraduate decision making process. I also solicited questions about the study. About a half of participants asked about the study and/or the availability of the result.

Data Analysis

Data were recorded with digital technology and transcribed verbatim. I analyzed the data in Japanese. I translated into English only the sections that included exemplars to demonstrate a theme. Although I attempted to accurately translate the excerpts from Japanese to English, and the translation was checked by the native speaker(s), some meanings might have been lost during the translation process. In order to avoid the loss of nuance of a directly translated statement, I added a word or phrase that was not spoken

but was implied by a participant in parentheses. I also listed participants' statements in Japanese in the Appendix (Appendix F: Original Quotations).

The constant comparative method is a technique used in grounded theory, but has been applied to other qualitative designs, such as case study. It requires researchers to collect, code, and analyze data simultaneously in order to do theoretical sampling (Glaser & Strauss, 1967; Strauss & Corbin, 1998). Because I had little control in sampling (i.e., I interviewed whoever volunteered once), identifying core categories as soon as possible was imperative for effective data collection. I started data analysis soon after data collection began by keeping field notes and compiling memos (Glaser & Strauss, 1967). After each interview, I took notes about my impressions and reflections of what I heard and observed. I developed an interview note for each interview. I recorded my initial analysis in memos separately from the notes. Data analysis at this stage helped me discover and establish units of analysis (Goetz & LeCompte, 1984) and assess answerability of the research questions (Hatch, 2002).

More formal data analysis started after the interviews were transcribed. Although I had several beginning categories for analysis based upon the theoretical framework, I relied primarily on inductive data analysis (Hatch, 2002). Although each interview question has a distinct purpose to obtain certain information, all data were analyzed for both purposes. At first, I coded any data that related to participants' college experiences and postgraduate decisions (i.e., open-coding) for descriptive purpose. At this stage, efforts were made to summarize the data according to what happened and what participants experienced. Then, I gathered coded concepts (i.e., categories) into groups and saturated each category with related concepts (i.e., properties).

In inductive analyses, which encourage researchers to discover emergent themes in the data, coding the data systematically according to the properties identified within categories ensures credibility of the study (Glaser & Strauss, 1967). Thus, I coded transcripts according to the salient properties I identified within the categories and determined properties that were supported by the data. In order to saturate the properties within the category, I identified any cases that did not fit the pattern. After I finished analysis within categories, I reviewed them to identity any relationships between categories. I relied on semantic relationships that Sprady (1979) recommended, including cause-effect, means-end, sequence, and attribution, to identify links between categories. I also developed tables to organize categories and properties.

Once I saturated categories, I identified themes based on the structure of the categories. I synthesized the patterns in writing, and described the identified patterns by using examples from data. During this process, I continued compiling memos and interpreted them in my analysis. I used the theoretical framework and the literature to create concepts to describe the participants' experiences. I used important concepts within identity theory, such as commitment and interruption of the identity process. For example, I tried to determine whether and how a specific identity-related behavior (e.g., asking questions to their peers) facilitated or constrained the occurrence of other experiences and participants' development and maintenance of engineering identity.

In order to fulfill the purpose of this study, the analysis described above followed two distinct processes: to analyze what participants' collegiate experiences were like and how they made their postgraduate decisions. For the collegiate experiences, I primarily coded data that were related to their learning in engineering. Data were mostly drawn

from the second part of the interview. I grouped activities according to the settings (e.g., classroom, laboratory). Then, to reflect the different nature of interactions, activities were organized by individuals with whom they interacted (e.g., faculty, graduate students, peers). I paid attention to distinguish participants' own behaviors and perceptions of others in the department. Last, I started to develop themes that explain women's experiences across settings and individuals with whom they interacted. I also tried to identify abstract concepts (e.g., deference to others, passivity) to refer to concrete actions and experiences. These themes helped me understand the nature of women's experiences in the department by allowing me to make general statements.

To understand what participants' postgraduate decision making was like, I identified and coded data that described the process of decision making (i.e., when, how, why, with whom they consulted) and participants' considerations (i.e., what). Data were mostly drawn from the first and third sections of the interviews. Participants' narratives often were dominated by considerations that were unrelated to their experiences in college, such as their work values, life plans, and financial needs. Because this study focuses primarily on the role of college experiences in the development of their engineering identities, at the next level of analysis, I reduced categories to include only those related to college experiences. I only examined non-college-related considerations as they related specifically to participants' college experiences.

To determine the end of data analysis, I periodically reviewed the four research questions to judge whether they were adequately answered. In developing categories, I also referred to the research questions to be certain that I compiled sufficient categories.

Trustworthiness

I considered four criteria of trustworthiness: credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985). I achieved trustworthiness of this study mainly through triangulation, member checking, creating and using an audit trail, providing thick description, and peer debriefing. Triangulation was primarily done by the use of different sources of the same information (Lincoln & Guba, 1985). To do this, I asked participants to rate important points and compared those data to the open-ended interview responses. Interviewing multiple individuals at two institutions also made the data more credible because it eliminated the possibility of unintended bias stemming from an institution-specific context (Yin, 2003). Supplemental use of observations and relevant documents provided additional trustworthiness.

I used member checking as a primary technique for credibility. As previously described, I summarized what I had heard in the interview and asked participants whether my understanding was accurate. I also conducted peer debriefing with two women graduate students at one of the engineering schools who did not participate in the study. All records, including memos during and after the interviews and interview notes, are kept as an audit trail in order to assure dependability and conformability (Lincoln & Guba, 1985). I also provide thick description of the participants' experiences in my writing and participants' statements in Japanese in the Appendix. I conducted peer debriefing with a professor at Central University who is familiar with qualitative methods before data analysis was complete. My advisor, who is American and a native English speaker, also provided me with feedback throughout data analysis and reporting.

Nine months after the data collection, I unexpectedly obtained a term position focused on promoting gender equality at one of the institutions from which I recruited participants. My main responsibility was to develop a women-friendly environment in the university. I worked with a variety of university constituents, including professors, administrators, and women undergraduate and graduate students in an engineering school. The work experiences helped the analytical process by familiarizing me with the environment.

Ethical Considerations

I followed ethical research practices primarily by obtaining a signed informed consent form from each participant and protecting the confidentiality of the participants in reporting findings. An informed consent form written in Japanese was sent by e-mail to participants before the interview date so that they could ask questions before the interview or decide not to participate. At the interview, I explained the content of the consent form orally. Participants were informed again that their participation in the study was completely voluntary and that they could withdraw from the study any time.

In scheduling interviews, I paid particular attention to participants' availability and tried to be as flexible as possible. I was concerned that some participants might need to change the scheduled interview date or leave earlier due to research or other commitment. I asked at the beginning of the meeting whether they could stay for 90 minutes as planned. After an hour, I also asked participants whether we could continue the interview. Each participant was given a choice about whether to record the interview. I asked prospective participants their preference whether to record when scheduling an interview and again at the beginning of the meeting. I also informed participants that they

did not have to answer any questions that they did not want to. I was careful to maintain sensitivity to the participants' responses during the interview because, although unanticipated, some questions may cause students distress.

I informed participants that all data and related study materials, including signed informed consents and transcripts, would be kept strictly confidential and participants and institutions would not be identified by name in the report. Because participants were recruited through their school, I assured participants that the content of the interview would be kept confidential from the school as well.

Except in the excel file that includes both the ID and the full name of the participants, I used the numbered ID in the research process. Also, although using the name of the school would enable readers to understand the context of each participant better (Yin, 2003), I used the pseudonym so that the participants' confidentiality was further secured. I also decided not to use the name of students' department for the same reason because some participants were from departments with only a few female students.

Positionality

There are a few possible sources of personal bias because of my characteristics and assumptions. Like participants of this study, I am a Japanese woman who attended a national university as an undergraduate student immediately after graduating from high school, although my major was not engineering. As such, I might take certain things for granted because of my own experiences. My point of view, however, may be different from the participants who never worked full-time or studied in a graduate program before. I returned to a graduate school after working several years. I worked at three national

universities in Japan for 9 years in total. I also worked and studied in the United States for several years.

I also made several assumptions related to the study that may influence my interpretations: (a) undergraduate education should contribute to graduates' career to some degree, especially in the practical field as engineering; (b) individuals should be able to obtain educational and career opportunities regardless of their gender; (c) most rational individuals choose the option that benefits themselves the most in the existing system; and (d) individuals decide what to do in life during college to some degree.

Limitations

There are several methodological and interpretative limitations in this study. First of all, readers may find it difficult to transfer the findings of the study to engineering education in the United States and elsewhere, due to differences between the higher education system of the United States and that of Japan. This study illuminates the experiences of a specific group of women engineering students in Japan. However, readers may find aspects of this study transferable to their own settings. Further qualitative and quantitative work must be conducted to confirm the consistency of these findings across universities.

My participants do not represent the population of Japanese women who study in engineering. Every year, approximately 3,000 women enter one of the 46 national engineering schools in Japan (MEXT, 2008). Each engineering school attracts students from different regions and levels of academic preparation. I recruited participants only from two modestly selective, similarly sized national engineering schools. Those who were final-year students in the academic year 2009-2010 might have unique experiences

compared with their counterparts from other years, reflecting the economic conditions and other social events occurring at the time they determined their postgraduate plans. The two most important events were the economic downturn and the movement toward gender equality in higher education. The current national efforts to increase the number of women researchers and students in STEM started in 2006 (Gender Equality Bureau, Cabinet Office of Japan, 2012; Osumi, 2006), when participants of this study were first-year students. Since then, both universities have received 3-year grant for this effort from MEXT (2007 as in the case of Western University and 2010 as in the case of Central University). Thus, the climate of these engineering school may have been changed since the time of data collection.

The data I used are a product of participants' reconstructed knowledge of their experiences in the department. It is largely up to the participants' ability to reconstruct the reality. I cannot deny the possibility that the information I obtained from the participants, especially of their early years in college, was influenced by their more recent experiences or their chosen postgraduate plan. Also, participants who responded to a solicitation from the school administration may have different perspectives about their experiences than those who did not. Despite the self-selection of participants, the data were rich and descriptive.

One methodological concern with this study is that participants in this study did not share the exact same educational environment. I recognize the merit of contextualizing the study by conducting a study at a single department. However, there are at least two obstacles. Few Japanese engineering schools, which have been struggling to attract students, would be willing to be studied as an organization by a doctoral student.

Also, the number of women students in any one department would be too small to ensure enough participants to make meaningful conclusions. I concluded that it would be more beneficial to collect data from as many students as possible even though their environments may not be exactly the same and present the research as a case study of "Japanese women engineering students," comparing two different groups of students: those intending to enter the workforce (Work) and those intending to pursue a master's degree upon graduation (Degree).

This study explored the process of women's decisions to pursue a master's degree by asking questions broadly about their college experiences. It is not the purpose of this study to identify and measure all the factors that influence on their decisions. Although participants shared their college experiences with me in the study context of understanding women's decisions to pursue a master's degree, participants did not always talk about their experiences as a cause of their decisions. There is room for interpretation. Thus, this study is limited in claiming the relative importance of college experiences in participants' postgraduate decisions. Also, this study, which focused on women's experiences, is not intended to investigate the differences in educational experiences and aspirations between men and women.

In this study, I compared participants' experiences by their postgraduate plans not by their engineering identity. In order to understand the role of collegiate experiences in identity development, I would need to have measured the strength of identity. There is a possibility that participants will change their postgraduate plans later, or that those who go on to master's programs will ultimately not work in technology-related fields for some reasons (e.g., the economic situation or change of interests). In fact, the participants' plan

to pursue master's degrees does not guarantee they will be admitted into the graduate program or obtain an engineering job. In this study, I considered how individuals chose different options after college hat provided them with different opportunities for engineering-related positions at a particular point in time.

As a result of analysis, three themes that describe participants' experiences (women's perceptions of being women in engineering, learning experiences, evaluation of themselves as engineering students) emerged. Also, the process of deciding their postgraduate plans is differentiated by participants' perceptions of engineering career and graduate programs. I will report the findings in Chapter 4 and discuss their implications of the findings in Chapter 5.

Chapter 4

FINDINGS

In this chapter, I describe participants' experiences in their respective programs in their first 3 years of study and how they interpreted those experiences that were relevant to an engineering identity in relation to their postgraduate decisions. The first three themes describe participants' experiences (perceptions, behaviors, and self-evaluation) and the last theme describes the process of deciding their postgraduate plans.

In each section, after a broad statement of key themes, I will introduce examples to substantiate the findings. Examples are chosen from participants with both postgraduate plans. Exceptionally positive experiences of women as well as experiences characteristics to participants who decided to pursue a master's degree (Degree) will be illustrated in a subsection called Positive Cases. I will only occasionally use modifiers or exact numbers to help readers have a sense of the prevalence of the phenomena because it is inconsistent with qualitative methodology to quantify findings. In order to protect participants' confidentiality, I will use pseudonyms with the plan after graduation at the time of interview (i.e., Degree: plan to pursue a master's degree; Work: plan to obtain a full-time job) and the name of the institution the participant attends (i.e., Central or Western).

Being Different within the Program

In general, participants were aware of their difference from the engineering students. Some participants negatively took the difference, especially when they interacted directly with their male peers.

Social Isolation

Participants perceived that they were socially isolated within the department. Because of the gender-based socialization within the department, participants were slow to be integrated with others in the program, a large majority of them were men. Participants were typically acquainted only with women students in their cohort during the first one or two years in the program. Yoko (Degree, Central), who lacked any contact with men students in the department until the end of the first year or so, described the departmental climate at that time as follows:

> It was not very smooth at first. It appeared that the department is a men's world. It did not seem to matter whether women were present in the men's world or not [….] Male and female students were separated. That's why we women formed our own world.

Although they believed it problematic to have only women friends, participants had little recourse to change the situation until laboratory work in that students worked in pairs or groups in and outside formal class hours became a larger part of curriculum in their third year. Women appreciated the social aspect of laboratory work, which offered considerable opportunities for students to become acquainted with their peers, and extended their circle of acquaintances within the department. Some participants expressed their wish that if students had opportunities to do something in class together, they would have become acquainted with men earlier.

(Ambivalent Feelings of) Special Treatment

Women realized the rarity of women in engineering and their visibility as they interacted with others within the department. Some participants shared their experiences

of being surprised by men's attitudes and behaviors toward them. These participants seemed uncertain what these experiences meant and how they should react.

Some participants realized that men students tended not to let them do the work in the laboratory, especially when physical tasks were involved. Participants seemed to consider men's over-protective behaviours engineering-specific and unnecessary, although they did not complain about it. For example, Erika (Degree, Central) thought that she was lucky because she often did not need to do "difficult work" in the laboratory. However, Kumi (Work, Central) indicated her discomfort. She indirectly criticized the practice by claiming that she did not want to be exempted from a physical task in her future work as a medical representative just because she is a woman, although it might be the norm in the engineering school. Participants with such experiences seemed to be reminded that they were physically weaker than men, which indicated they were inferior. This perceived weakness took opportunities to perform tasks away from them, limiting what they might be able to achieve.

Some participants noticed that they were considered as needing extra attention by professors who were almost always men. Women, who rarely approached instructors, perceived that instructors communicated with them more frankly and were more helpful in individual settings than in the classroom. Some participants also heard that faculty in the department extended their help more willingly toward women than men. With the benefit of hindsight, Kumi (Work, Central), who remembered that instructors and teaching assistants sometimes kept men waiting and answered women's questions first, suspected that they behaved differently because she is a woman. Kazumi (Degree,

Central) shared a rumor about the unit chair she heard from advanced students in her research unit, which she was unsure of:

> Still, graduate students say that they have never seen the professor criticizes female students before. I am not sure whether these persons did a good job or not, though. They said that the professor is strict toward male students but not toward female students. I wonder whether it is because professors had to be careful about their words, though. I heard that.

Lack of Information and Role Models

Because of their isolated status and perceived difference with other engineering students, participants, who were interested in technology-related fields when they entered the university, felt disadvantaged in their professional pursuits. Participants were not well informed of the career in engineering or the steps they should take. Participants complained that they had difficulties understanding the value of studying in a master's degree program. With regard to career exploration, which closely linked students' decisions to pursue a master's degree, participants did not want to share their personal concerns with the faculty whom they barely knew. In particular, those who did not plan to pursue a master's degree (Work) expressed doubts about asking professors their opinions regarding options after college. Participants appreciated information from advanced students, but their occasions for becoming acquainted with more experienced students were limited to classes with teaching assistants or departmental organizations such as student governments and women's alumnae associations.

In their membership group, participants shared information from advanced students in STEM disciplines. However, some Work students were hesitant to share their

career-related concerns with their peers who pursue a master's degree. For example, Kotoko (Work, Western) dismissed the point of asking for help from faculty members who were likely to recommend pursuing a professional career after obtaining a master's degree and commented talking with her friends in the program who were mostly men and planned to pursue a master's degree as follows, "I did not share my thought [about life after college] with my classmates because they would not understand me." She was convinced in her second year that her desire to leave engineering after graduation was acceptable or even reasonable for women in a conversation with a male graduate student. Similarly, Misato (Work, Central) who initially planned to obtain a master's degree needed to reconsider her plan when her parents had a financial problem. She thought that professors did not understand her situation. She was disappointed especially when her male advisor just nodded and made no comments when she tried to share her problem:

> Once I told a professor that I was not certain about going to a master's degree program. He is a male professor, by the way. He simply said, "Do you?" I was stunned because that's the only response I got from him.

Misato, who was later informed of alternative career options in technology-related fields, which did not require a master's degree by a female research staff in her research unit, wished if she had opportunities to talk with women in her field about possible options before. Few participants claimed they had minimum access to women faculty or graduate students in the department. Still, as the examples above indicate, participants considered gender relevant for career exploration.

Positive Cases

Some participants were less concerned about their differences in the department and felt more informed about study and career in engineering than other participants. Participants' perceptions of being different were little different according to their postgraduate plans. Yet, having a plan to pursue a master's degree seemed to advantage women in identifying with others in the department, including men.

Participants who interacted with men were more integrated into the department than others. These participants, who typically described themselves as outgoing and able to seek help from anybody, claimed that they needed to extend their pool of friends to include male students. Degree students, who had a greater stake in becoming integrated within the department, were particularly aware of the academic benefits of their association with men and acted accordingly. In their third year when students mostly engaged in laboratory work, Degree students who did not have prior relationships with male students actively socialized with men in the group and took advantage of the relationship. Erika (Degree, Central) perceived that she became more assertive after entering the university. Despite initial difficulties, she gradually became more comfortable in working with male students. She interpreted that it was a natural progression:

> Since I started a program, there had been only a few women. Well, I mostly saw men students from the beginning. I would feel a bit lonely if I only had female friends. My options with whom I make friends would be limited if I only befriended female students. I think it was a natural thing for me to make friends with men.

Some Degree students and a few Work students who planned to pursue a career in technology-related fields without a master's degree sought information from faculty more actively and successfully than others. They obtained advice on highly field-specific issues, including the implications of skipping a grade or pursuing a master's degree at a more prestigious institution, and sought feedback on their fit for the field. These active women highly evaluated the professors' expertise and perceived faculty knew them well. These students seemed to be mindful with whom they approached when the conversation involved non-course related topics, reflecting their general reservations about faculty member's approachability. Kimi (Work, Western) and her female friend, the only two women in their program, visited her faculty advisor together once a month or so, although her friend's advisor was a different professor. They found only Kimi's advisor approachable after several course-related contacts.

Constrained Engagement in Engineering Learning

Participants, reflecting their challenging learning experiences in engineering, considered that they had managed to survive the coursework. Participants perceived that their work in engineering was constrained by poor teaching and little guidance from faculty at the early stage of their program of study. At the applied stage of their program, participants experienced the challenges of participating as tokens, and deferred to men in laboratory work.

Unproductive Learning

The participants were generally dissatisfied with classroom experiences in engineering. In their first year, participants were somewhat lost because they received little guidance on how to study engineering in general or a certain subject in particular.

Some participants complained that introductory courses did not stimulate their interests in the field. For instance, Natsu (Work, Central) thought that engineering classes failed to offer what she thought of as college-level learning: She had heard from her older sister that college professors convey to students how interesting the research is.

Another source of complaint was the teaching practices. Although participants varied in their assessment of the prevalence of poor teaching in their programs or the impact of that poor teaching, they were critical of the instructional methods or the coordination of courses within the program. In classes that participants targeted for criticism, they said instructors typically explained the material without regard for students' levels of understanding, and mechanically followed a textbook and showed PowerPoint slides. In the rare classes that students liked, instructors offered the material in a step-by-step manner and occasionally presented demonstrations and hands-on learning opportunities. It was common for participants to consider that classroom experiences depended on the instructor and attribute their conceptual difficulties or sense of ineptitude in their classes to the poor instruction. Kazumi (Degree, Central) shared her observation of poor teaching and its consequences for her learning:

> An example of a class where I would question the quality of the teaching was the class in which an instructor wrote equation after equation on the blackboard. He didn't take questions on what he was teaching or explain the equations he wrote. When I reviewed my notes, I had no idea what we had learned. I had a hard time preparing for examinations in his class.

Participants inferred that the one-way instructional method that did not engage students reflected not only the instructor's poor teaching skills but also lack of interest in

student learning. A Central student, Yoko, (Degree), inferred professors' disinterest was the reason that professors in her department generally ignored students' misbehaviors (such as napping in class and sneaking out of the classroom). To her eyes, professors considered that only "smart" students who understood materials mattered.

Detachment from faculty seemed to be common. In response to perceived poor teaching practices, participants did not engage in the instruction actively or ask questions in the class. When participants could not concentrate on the instruction, all they could do during the class period was to take notes for future study. Participants seemed to believe that their inactive participation was excused because they observed students in their program to be generally unresponsive in the class, except for a few "smart" students who were always men.

Poor experiences in the classroom further discouraged participants from pursuing necessary contacts with the faculty outside the class. Participants were not willing to approach faculty unless it was required or absolutely necessary (e.g., receiving course materials they missed). In addition to the gap in social status between undergraduate students and faculty – participants seemed to believe it was inappropriate for undergraduates to initiate contact with busy, important professors –, participants perceived faculty held high standards for engineering students based on the professors' attitudes and comments in the classroom. Only when a professor showed a welcoming attitude in class or verbally encouraged students to ask questions anytime, did participants feel encouraged to visit him for help.

Participants' infrequent interaction with faculty also reflected on their self-protection strategy. Participants thought it important to be considered competent and

avoided exposing their lack of understanding to faculty. For example, Tomoko (Work, Western) rarely asked professors questions, although she considered it beneficial to ask an expert: "When I asked the professor questions about the material he had already taught, admitting that I did not understand, I felt embarrassed." Hatsu (Degree, Western) rationalized that an office visit was unnecessary after hearing that a professor addressed a demeaning comment such as "I don't believe you don't understand such an easy matter" to a friend of hers:

> The professor might have answered the questions if I asked him. However, I wondered whether I should ask such a trivial question. It was hard for me to go to the professor's office.

Participants generally self-studied and sought help from their friends when necessary. Regardless of their study styles, participants thought their learning was inefficient and unproductive. For example, Mei (Work, Western) reported that initially it was somewhat difficult for her to judge when and what she should study in a class that did not require students assignments. As a result, she did not think she studied as proactively as she did in high school. Reflecting initial challenges, she claimed that opportunities to confirm students' understanding should be formally implemented. Similarly, Mizue (Degree, Central) wondered whether she had to study for long hours because she did not know how to study efficiently, although she had a reputation for being smart and her cumulative grade point average exempted her from taking an entrance examination for the master's degree program.

Challenges in Group Work as Tokens

Participants felt uncomfortable and disadvantaged as learners for various reasons in environments where women needed to work as a lone female member in a group. They were generally content doing practical work with their peers. Femininity seemingly had constraining effects on the behaviour of a few women who considered it important to be feminine. Still, the lack of familiarity with group members and their token status were the causes for participants' discomfort. Participants were socially excluded from the group work. Mei (Work, Western), who perceived it a challenge to work in a group as a lone female member, doubted her full membership and complained about the superficial nature of group cooperation that existed only to complete a task: "[In our group] the men and I talked, but we only talked when we needed to talk." Based on her experience across semesters, Mei concluded that the group climate primarily depended on the men who appeared to have distant attitudes toward female students but had choices to act differently: "Only if male students initiated conversations, women would be comfortable."

Yoshie (Degree, Western) complained that women in her program usually were excluded when students in the same group met voluntarily outside the laboratory. She described a typical situation when men decided to meet after class as follows:

> Male students got together naturally after school. First, after we finished the laboratory work, we said to each other, "Good job. 'Bye." Then, girls and boys started walking separately and left the school. Among boys, someone would say, "I will go to library after supper." Then another boy would say, "I will go there, too. [Let's study together.]" But the girls…

> Q: Boys did not ask girls because you were not with them?
>
> They didn't invite us to study. They occasionally would call us, claiming that they needed our help.

Yoshie was assertive enough to ask male members in the group to let her join them whenever she found them studying in the library. Yet, she admitted that women in her department, including herself, could not initiate or volunteered to participate in the meeting.

Furthermore, participants could not contribute to the group work as much as they wanted. Whereas some women had the perspective that group members shared tasks voluntarily, others thought that their role did not permit them a fair choice of tasks. The latter women perceived that men were more assertive in what they wanted to do and they had little control in deciding how the group worked. Participants who had problems with the task sharing resolved issues by deferring to the male students, especially when the group was dominated by aggressive students. It was Sayo's (Degree, Central) way to participate in the group work by voluntarily engaging in necessary, but peripheral, group tasks so as not to compete for the primary group activity. Sayo often let others complete the work and found herself in a supporting role when working with assertive men. She cynically explained the typical situation:

> I offered group members help: "Let me wash this." Sometimes, all I did was wash instruments for the experiments. I am the kind of person who feels responsible for whatever is left to do. If someone starts doing something, I will just let them do that [even when the task they have chosen is what I was going to do].

Although she was not satisfied that she did not learn much through the laboratory work by not performing tasks, Sayo evaluated her laboratory experience positively. Sayo thought she would have spoken with far fewer students if she had not worked in the laboratory. She also rationalized there were simply not enough tasks for all members to do when students worked in a group.

Others were more strongly obliged to defer to men, who appeared more competent to do the work, and became dissatisfied with their participation. Hatsu (Degree, Western) noticed that, in group settings, some of her male colleagues understood and performed the tasks better than her:

> When I worked with other students, I sometimes relied on them. There were times that I did not complete the task by myself. I think it would be better to work individually. We can ask when we don't understand the material. We can master the material that way. When we composed a laboratory report together as a group, other group members tended to take on a more difficult part than I did. When we made a presentation in class, I tended to let others take the difficult parts.

She was not satisfied because she not only did not do essential parts of the work but also played a role of accomplice in the process. Although Hatsu understood the importance of collaborative work, she concluded that she preferred to work by herself because she could then completely focus on the tasks at hand.

Collective Attempts to Engage in Learning

To engage in necessary but often challenging behaviors, participants, who needed to perform well in the program, typically studied and shared information and experiences with other women. The extent to which participants cooperated with their female friends varied. However, they all positively considered cooperation with their peers and perceived this collective action to be empowering and necessary for improving their performance.

First of all, participants formed and maintained their friendship groups within the department primarily for academic purposes. Participants spent the longest time with their female departmental friends during the semester, although they were not necessarily their best friends. Participants typically took classes, studied between and after classes, and asked instructors questions with their female friends. For example, Misato (Work, Central) thought it beneficial to study with her friends because she could receive help on a subject in which she was not performing well. Misato also reported that it encouraged her to prepare for the examination in a timely fashion because her friends wanted to start studying early:

> All of my friends in a group were a type of individuals who said to each other to start preparing the examination in advance. So, a few days before the examination, I was forced to think that it was a time for me to study. If I studied alone for the examination, I would just study the night before the examination.

Relying on help from peers that was easily available could be an effective strategy for participants who wanted to advance in their studies but lacked understanding or interpersonal assertiveness to do certain things. Yoshie (Degree, Western), who was

once unsure what she should ask when she did not understand a topic, started asking professors questions with her friends:

> When I was a first year student, I did not study diligently, assuming that I could obtain a passing grade. However, once I started to think about going on to a master's degree program seriously [, I changed my attitudes toward asking professors questions]. My friends and I said to each other, "We need credits for this class. Otherwise, we cannot advance to the next year." We would say, "We should go [to the professor's office] for this problem." Because it was difficult to visit professors alone, I usually visited them with one of my friends.

Furthermore, participants shared their individual experiences and perspectives with their friends as part of their exchanges among friends. Participants seemed to benefit from these exchanges. Students used the information to decide whether they should approach a certain professor or professors in general. They also tried to make sense of their group work experiences with their friends. For example, Suzu (Degree, Western), who was dissatisfied with her group work, remembered that she and her friends took comfort that their current group was better than the previous ones. She thought that her prior group work suffered due to poor communication between men and women. Yoshie (Degree, Western) discovered that other women in her department were also struggling with the overwhelming content of the course only when she was hospitalized due to her hard work because one of the women asked her whether it was indeed the coursework that burdened her. Yoshie later had arrangement with one woman in the department to go to spas regularly. She analyzed that women in her department had harder time than men because women tended to complete assignments by themselves as much as possible.

Positive Cases

Participants perceived different levels of challenges in engaging in formal and informal learning in engineering (e.g., completing assignments, working in groups). Some participants who engaged relatively easily in their engineering studies seemed to have a better understanding or broader network of support from others. They had more positive perception of the department and performance at the later stage probably due to their active engagement.

Not surprisingly, some students focused on the instructions in class better than others. These students tried not to fall asleep or miss anything even when they thought the material difficult or instructions poor. For example, Megumi (Degree, Central) reported that she usually took classes very seriously:

> I don't like to review materials. I was attentive during lectures. I was irritated when other students talked during the class. Well, it depended on the instructor, though. I was not so serious in classes that I found meaningless. Basically, I took classes well.

A few participants, all of whom planned to pursue their master's degrees (Degree), were not even bothered by specific instructional methods. They only recognized different teaching methods. Some participants also made it a habit to clarify their questions as quickly as possible. These active students asked their fellow students outside their membership groups or instructors questions if necessary, even though they never asked questions during class. For example, Kei (Degree, Western) rarely joined a study group because she could not concentrate on her studies. She studied diligently by herself and asked professors if she needed:

> I wanted to be able to explain professors what point I didn't understand. I would say, "I've been trying to solve the problem this way, yet I still don't understand this point." I wouldn't be able to understand professors' explanation if I asked them something that I had no idea of. So, I only asked professors what I really did not understand. I tied to understand what point I could not understand [before asking questions].

Because of diligent studying, Kei evaluated the level of her understanding at 20% when taking classes, but understood 100 % when she took the exam.

Those who made friends with men in the department academically benefited from broader networks. They could easily complete assignments without perceiving much trouble. They studied the material as a group, using information from the past and their broader network. This is in contrast with most women who do the work by themselves first even when they engaged in the work physically together and only asked for help when they did not understand.

Participants who were less constrained in their engagement in learning either by understanding more or having others whom they ask for help were mostly Degree students. There is no tendency that Degree students seek help from faculty more actively than Work students, but Degree students appeared more eager than Work students to find answers to their questions. Some of their interactions with men were academically strategic. For example, Kaori (Degree, Western) sought help from a few male students whom she identified as high-achieving when she had difficulties completing assignments.

Active engagement in engineering learning appeared to reduce constraints. Participants who started asking course-related questions early in their academic careers

were typically comfortable approaching professors even for non-academic reasons. For example, Yayoi (Degree, Western), who was advised to skip her fourth year and enter a master's degree program at the institution, initially thought it "scary" to approach professors, "who looked grand and different from high school teachers." However, Yayoi came to feel more comfortable with asking questions and seeking career-related advice after she found professors taught her kindly.

At the applied stage, some women managed to participate in group work more actively than others. Those who participated actively were satisfied with their experiences and considered the participation as evidence of their aptitude in the field. However, only a few students claimed that they contributed to the group work in a significant way by taking a leadership role or performing what they wanted to do aggressively. As compared to students in Work category, Degree students were eager to participate and contribute to the group work and actually do the work by themselves in the laboratory, although some of them had challenges in doing so.

Some participated in group work successfully by focusing on group dynamics and relationships. This nonaggressive strategy, only Degree students mentioned, seemed working. For example, Kaori (Degree, Western) played a "connecting role" by easing tense communication in the group without being regarded as threatening by men. Kaori considered that she, as a woman, was an "outsider" to the competition:

> I kind of created the climate in which group members were comfortable discussing. I talked to anyone in the group [to promote discussion]. I think that is the role women should play.
>
> Q: A role?

> Yes. And I think we can play that role because we are not included in the men's competition.

Not all group members were friends; Kaori understood that communication among men who were not friends could be awkward due to their competitive attitudes. She worked hard to ease group tensions. In the end, she was satisfied with the outcomes of the group work, which gave her confidence in pursuing a career in the field.

Lowered Self-Evaluation

Participants used grades to assess their global fitness for engineering and their relative strength among subjects in their program of study. Participants perceived that their grades did not reflect their efforts or sense of mastery. In evaluating themselves as future engineers, thus, participants did not consider formal evaluation absolutely reliable. They instead based their self-assessment on direct interactions with faculty and male peers.

Feeling Unrewarded for Hard Work

In lecture courses, participants often did not understand and felt left out when an instructor taught the materials without consideration for students' understanding (e.g., prepared little, provided students little feedback, or did not take questions positively). Instructors in such classes seemed to assume that students should be able to understand course materials taught in any manner. Although participants did not interpret that the instructor's attitudes and behaviors were solely toward women, the perception that they were not doing well enough seemed to prevail in classrooms. For example, Natsu (Work, Central), who was surprised to find professors in her department dispensed information in textbooks without enthusiasm commented:

In college, professors teach in a way that [implies] they don't care whether we understand. The way they teach indicates that it's our fault that we don't understand because we don't listen attentively to what they are saying. It may not be appropriate to describe this way, though.

Q: Do you mean if you don't listen to the lecture?

Yes. In the class. I didn't think that professors wanted us to understand the material when they lectured.

Kumi (OK15, Work, Central) did not like the instructor who taught at a fast pace and told students that they should understand the material. She attended his classes without expecting to understand anything during the class:

I liked classes in which the professor broke down the material. If the professor taught us step by step, I understood. I would say, "I got it." However, there was a professor who seemed to tell us that the content was obvious and we don't need an explanation.

Q: He assumed your understanding without explanation.

Without explanation, the professor would say things like "Since you have studied the subject, you should be able to understand this."

In addition to faculty's discouraging behaviors, what exacerbated participants' insecurity was the presence of men who did not appear to study as diligently as they did but received excellent scores in exams. Participants suspected that these men either studied more efficiently or effectively or already had a good understanding of material. Participants who believed that grades did not fairly reflect the amount of study time they invested, particularly when compared to their male peers, were discouraged to pursue an

engineering career. For example, Tomoko (Work, Western) had not previously thought of the difference between herself and others with regard to the level of aptitude:

> There were people who could solve the problem because they understood the material even though they did not study for the examination. There were also people, including me, who obtained a good grade as a result of studying for many hours, putting much effort into it. I realized the difference between so-called geniuses and hard-working people.

Loss of Confidence in Laboratory Work

At the applied stage, when students had more opportunities through laboratory work to observe others' products and work patterns, participants felt inadequate more strongly than before and made low self-evaluation because of the perceived quality of the men students' work and intensive work style. Contrary to their prior perceptions of male students, who dispensed little effort for coursework, participants first observed that men were much more invested in their work and thus created excellent products. It did not seem to matter to participants what evaluation their end products received formally from faculty. They suspected that working overnight before due dates, sometimes at someone's apartment or at school, was the norm in engineering school. Mei (Work, Western) was one of them:

> When we developed a computer program for the experiment, I sometimes felt that I would not be able to work as hard as some other [male] students, to the extent that they put efforts into their work. Even if I worked harder, the product I develop would not have the same quality as the one that these people develop.

> With the same amount of effort, I don't think I can create the same quality program that these other students create.
>
> Q: You thought that when you observed other people's work.
>
> Well, I realized that there were many people who were more competent than me when I worked in the laboratory.

Similarly, after starting group working, Yayoi (Work, Central) wondered whether she was performing well enough. She thought that male students understood the material well, prepared more before beginning the work, and wrote better lab reports. She brought up her observation of male students in describing reasons she relinquished her plan to pursue a master's degree.

Furthermore, men's openly confident attitudes towards the tasks also increased participants' insecurity in group settings. Participants found that men tended to work competitively and speak critically of others' performance. Some women doubted their competence when they worked with men. For example, Moe (Work, Western) thought that some people performed better than her in college. She perceived men who pointed out and corrected others' mistakes were smart. She thought she did not have such confidence. Besides, she sometimes did not understand what they were talking about.

Participants were particularly discouraged from their own poor performance. Jun (Work, Central) was embarrassed by the presence of others in a small group setting because she often failed experiments. She had come to develop a sense that she was not good at doing the experiments:

> Because I often made mistakes in the experiment, I felt embarrassed. My co-worker would tell me not to worry, though. I guess that's why I had grown to dislike doing the work.

Jun claimed that lack of technical dexterity and attentiveness to details were the reasons for her poor performance and did not attribute her gender as a factor related to her performance. However, she perceived pressure from her group members, and indicated that the men's presence caused stress and influenced her performance. These perceptions had long term implications, as participants who decided to leave engineering once they graduate often cited poor performance in the laboratory as a reason for their sense of inaptitude.

No participants stated that they personally received insensitive comments on their performance from male students (e.g., "You are not good enough"). However, women seemed to become conscious of their performance and the consequences of their performance in the presence of male peers. Sayo (Degree, Western) reported that her women friends were discouraged from working in a group by receiving a blatant criticism from male peers concerning their work.

Positive Cases

Few participants claimed they had no challenges in understanding the materials or performed better than the men in their group. Yet, some participants were relatively confident in their performance. Despite many cases of perceived inadequacy, participants had opportunities to embrace their success. Some participants, mostly Degree students, realized that their understanding increased as they proceeded to the applied stage of the program of study. This understanding smoothed subsequent learning and provided

participants with the sense that they were rewarded for their efforts. For example, Kimi (Work, Western) thought she understood the meaning of the formula better because she was repeatedly exposed to the same material. She also found that the work in her field did not require physical work on the contrary to her initial concerns of women's ability to do engineering work. In Kei's (Degree, Western) case, working in the laboratory provided her with the opportunity to link materials and a motivation to understand difficult materials by studying diligently:

> It became difficult as the course level increased. When it became difficult, I sometimes wondered whether I wanted to study that hard or I really wanted to study [name of the field]. However, in the third year, we did more experiments and wrote a discussion in the report. I liked those kinds of stuff, to conduct experiments and think hard why it happened. I thought it was inspiring to conduct experiments than to study. I wondered why certain things happen. Then, I tried to understand difficult materials in reference books.

Informal group studies with friends were opportunities for participants to confirm their understanding and learn their relative academic standing in the program or relative strengths in certain subjects in non-competitive interactions. Some participants experienced social interactions positively especially when they were helping their friends. By comparing their aptitudes with their peers who were not doing as well, some participants developed a stronger sense of confidence and competence. For example, Kazumi (Degree, Central), who was initially intimidated by her classmates who seemed to have a better academic preparation, understood that she was performing well enough by participating in group study with her college friends over the years. Mizue (Degree,

Central) observed that her female friends in the department just wanted to know the answer and cared little about the process while she was not satisfied with only getting the correct answer:

> I tend to think why a certain answer is correct and why another answer is wrong. When I told my friends what I thought on the assignment, they just replied "You're a genius. Why would you come up with that?" That's how they would respond. […] They just asked me, "What's the answer?" And then [after giving them the answer] they said, "Thank you." There was no discussion.

Although she appreciated the time with her female friends in the department, Mizue differentiated herself from her friends and considered it part of her learning to initiate discussions with some male students.

In the laboratory, participants became confident for different reasons. Active participation in the group work, i.e., playing a significant role in the group, working collaboratively, or performing the task successfully, is one reason. For example, Yayoi (Degree, Western) who directed the group work became confident of her abilities to conduct experiments:

> Well, there were some students who were not very good at conducting an experiment. I had to come up with something for them to do, in other words, what role that individual should occupy in the group work. We usually did the laboratory work in a group of two or three. When we worked in a small group, I often told others what to do, like "You do this, do this, and do that.

Optimistic interpretation of their work can be another source of positive self-evaluation. A few Degree students interpreted men's intensive work as a matter of

style and surmountable in other ways. Yoshie (Degree, Western) perceived it as a difference in gender working style. Male students procrastinate on assignments and work intensely for a few days. She could achieve the same goal by starting working on an assignment sooner and spend more days.

Some participants placed greater importance on enjoying what they learned in the tasks than the amount of work they did. In fact, many Degree students cited the laboratory where they confirmed of their interests in engineering work. Megumi (Degree, Central) reported she gained a sufficient sense of fit for engineering by finding a certain phenomenon interesting during her time in the laboratory.

Some Degree students did receive confirmation of their engineering aptitudes by receiving an exemption from the entrance examination for a master's degree program for their outstanding cumulative grade point average. The exemption provided the women who were wondering whether they should pursue a career in engineering with concrete evidence of their high performance abilities, at least institutionally. However, students received the exemption only at the end of their third year, and by that time prospective graduates already decided their paths after college. Overall, many Degree students maintained a certain sense of control in their work in terms of amount of effort and outcomes, which may have fostered their more positive self-evaluation.

Postgraduate Decisions Making

In this section, I will describe how students who were making different decisions about postgraduate study based on their future plans had different evaluations for work in technology-related fields and participation in master's degree programs. Participants were officially advised that those anticipating professional careers in technology-related fields

should obtain master's degrees and consider programs in their current department as an option. Although participants had become aware of the necessity of obtaining a master's degree at some point, many participants were not convinced enough. Participants' decisions to pursue master's degrees were the result of assessing the costs and benefits of graduate study in relation to their future goals, which were professional work in technology-related fields that required a master's degree. Participants who decided to begin working full-time after college (Work) secured a job because they wanted to prioritize their family over engineering work in the future and ensure their financial independence immediately after graduation. Those who decided to pursue a master's degree (Degree) on the other hand considered it more important to pursue their professional goals in technology-related fields than to start working immediately after college.

Work students: Those Who Decided to Work Full-Time

Work students' decisions not to pursue master's degrees were motivated by several considerations. In their narratives about their decisions, participants often cited future family responsibilities and a desire or necessity to start working. In addition to becoming financially independent, participants were concerned about being too old to find a life partner if they waited another 2 years to start working. A lost or diminished interest in engineering work was another reason for not pursuing master's degrees. Participants' experiences in college did not appear to convincingly stimulate their interests in engineering or increase their confidence.

Work students were divided into three subsets according to the jobs they sought and finally obtained. The first subset of Work students realized at some point during their

coursework that engineering was not for them and decided to leave the field upon graduation. The second subset of Work students did not intend to leave engineering, but ultimately decided to do so when they realized the difficulties in obtaining engineering jobs or when unsuccessful job searches led them to non-engineering jobs. These students obtained positions unrelated to engineering, such as medical representatives and bank personnel. The third subset of Work students had sought and successfully obtained jobs in technology-related fields, although these jobs were only peripherally related to their specialties and, as is typical of jobs obtained by recent college graduates, not prestigious. They considered it unnecessary to pursue master's degrees. This subset included participants who had some positive experiences in the department.

Lack of Interests and Confidence in Engineering Work

Discouraging experiences in the department made some participants aware of their lack of competence or interests in the field. In particular, hands-on laboratory experiences led these participants to assess themselves as unsuited to engineering jobs. Unsurprisingly, those who perceived a lack of engineering aptitude decided not to pursue master's degrees or careers in technology-related fields. They did, however, persist in obtaining their bachelor's degrees.

For example, Yori (Work, Central), who initially wanted to become a researcher, cited her poor performance and the binding laboratory work as reasons for her departure. She thought that it would be better to obtain a sales job because she liked to work with people. She described how she disliked laboratory experience, during which she just followed the process without understanding what she was doing and often failed the experiments:

> I felt constrained waiting for 5 minutes or an hour to complete a certain procedure. Because these experiences seemed restrictive to me, I thought that I was not fit for a job that required laboratory work.

She continued, "It takes great long hours. I cannot leave freely. We don't know when the work will finish. It seems like that our life is controlled by the work we do. I think that aspect of laboratory work also bothers me."

Most participants in Work category did not have such strong negative feelings toward engineering. To them, the main issues were doubts about their futures as engineers. It was common for Work students to express concerns about large, demanding workloads and a hectic life style as reasons for not pursuing engineering careers, particularly in research positions. Participants had developed a negative image of researchers who do laboratory work all day without seeing other people. They were uncertain whether it was worth investing in a career that they might not pursue further. In particular, participants who ultimately obtained non-engineering jobs emphasized the costs of attending master's degree programs, a concern stemming from their uncertainty about their future professional goals.

For example, Natsu (Work, Central) could not imagine herself working in engineering when she started looking for a job. She decided to work in the banking industry where she could make good use of her meticulous work habits. Moe (Work, Western) decided not to pursue a master's degree because she did not consider research to be a possible option for herself. Still, she was aware of the benefits of enrolling in a master's degree program (e.g., increasing the odds of obtaining a job in engineering,

gaining insight in their career interests, having more research experience) and planned to continue working in technology-related fields until retirement:

> When I recognized that we could be researchers, I thought that it would be very interesting for someone who likes doing research.
>
> Q: You learned about the research positions and the availability of these jobs. Yet, you did not think that it was something for you.
>
> I could not imagine that I would be actually doing research for a living.

Participants did not know exactly what work in technology fields entailed or whether they would eventually have a family. However, participants wondered whether they could manage the seemingly large amount of work that engineering required while being married. Such a workload would make it difficult to balance their work and family lives. That is probably why some Work students chose non-engineering jobs or less demanding jobs when seeking jobs in engineering and/or chose positions near their parents' homes to mitigate these perceived obstacles.

Being a woman seemed matter to participants in Work category. Not knowing many people working in technology-related fields and the lack of male and female role models seemed to increase the participants' uncertainty about pursuing careers in engineering. Apart from a few individuals whose fathers worked in technology-related fields, people in the department, with whom participants had difficulties identifying, were the only role models available to the participants. Those working professionals who had opportunities to interact with the participants reinforced their concerns about being women engineers. For example, Sachi (Work, Central) was dissuaded from pursuing a research career when female speakers invited by the department mentioned the challenge

of becoming a researcher and returning from maternity leave. Sachi wondered whether she wanted to work every day in the laboratory, although she thought a research job would be interesting. Similarly, Misato (Work, Central) realized that there were only a few women in the program and they did not appear to have families. She thus felt doubtful about her chances of pursuing a career in engineering.

Participants shared their perceptions of gender-based differences and work-life issues with their parents and significant others, but not as often with those in their department. However, their traditional perceptions were reinforced in interactions with other women who also planned to work full-time. Individuals in Work category often described differences between themselves and Degree students in terms of their aspirations. They claimed that they were not as career-oriented as their peers, who planned to pursue master's degrees. For example, Kumi (Work, Central) perceived that her classmates had priorities which were different to hers. She considered it important to manage her housework well in order to continue working until retirement. While she wanted to live near her parents' home to manage her work and family life, she noted that her classmates did not care where they lived, prioritized what they wanted to do for living.

Negative Attitudes toward Pursuing a Master's Degree

Although participants had developed a more concrete image of graduate work, as they proceeded through the program, they had negative attitudes toward pursuing a master's degree due to a limited understanding of graduate work. However, the reasons for this negative attitude and that for their unwillingness to work in engineering were different. Some participants concerned whether graduate work would be manageable. For

example, Sachi (Work, Central), although she planned to obtain a master's degree since high school, had not been completely sure whether she should pursue a master's degree or not for a long time because she could only guess what graduate school was like from casual observation of graduate students in her department.

Other participants wondered whether graduate work would be worth their efforts. Work students' perceptions of graduate work as an investment to future employment played a role in their decisions not to pursue master's degrees, particularly among those who were interested in working in technology-related fields. These students, based on a rigid view of graduate education, questioned the meaning of the graduate work offered in engineering and doubted whether they would benefit professionally from a master's degree program. They did not seem to be concerned about their preparation, but annoyed by the presence of peers and advanced students intending to pursue master's degrees primarily to increase their odds of obtaining professional employment, not to pursue an academic career or to satisfy their intrinsic interests in engineering. Mei (Work, Western) reported that she was discouraged by a story narrated by a male advanced student:

> He told me that we would have much free time after entering a master's degree program. Given expensive tuition, however, I did not want to go to a master's degree program if the only benefit is to have free time. Of course we would study, but if this is the case, I think it is better to get a job and become independent [than to go on to a master's degree program]…It is a sign of dependency. I was afraid that I would question myself [if I just had fun]. "What are you doing in a master's program? You paid tuition."

To make her point, Mei also claimed that graduate education would not provide her with everything she needed to know for a job. Mei fortunately landed a job in a technology-related field, although it was not the type of job she had initially wanted. She thus did not see any point in pursuing a master's degree.

Ironically, some Work students recognized the usefulness of master's degree study after entering a research unit and regretted that they had chosen to pursue jobs before gaining a better understanding of the field in terms of research and career. Tomoko (Work, Western) thought that she would have explored her career options more broadly if she had worked earlier in a research unit. Akane (Work, Western) also second-guessed herself after recognizing what graduate students were accomplishing in the research unit. She originally thought, based on casual observation, that graduate students had too much free time.

Degree students: Those Who Decided to Pursue a Master's Degree

Participants who decided to continue to master's degree programs (Degree) usually cited the need for master's degrees for professional positions in engineering as the reason for their decisions. Their level of decisiveness in choosing to pursue master's degrees differed, however. Some women chose graduate study even though they lacked a clear sense of understanding of the process and felt some uncertainty about the future.

Degree students were roughly divided into two subsets according to the extensiveness of their job searches, which reflected their understanding of the need for graduate degrees for professional careers. Participants with a firm plan to pursue master's degrees only engaged in exploratory searches (such as looking at websites for job openings or attending guidance seminars for graduating students) during the period when

prospective college graduates looked for jobs. Participants who wanted to start working as soon as possible engaged in their job searches more extensively; they directly contacted prospective employers, trying their luck at finding a professional job without a master's degree. When these students realized the difficulty of securing one, they did not compromise on the job they wanted and stopped looking for jobs. The time it took for individuals to reach this conclusion varied.

Interest and Confidence in Engineering Work

Women's interests in working in technology-related fields most strongly supported their decision to pursue master's degrees. In fact, this was the only motivation for many participants to pursue graduate degrees despite the perceived obstacles and costs, including their low self-evaluation as future engineers or uncertainty about the future. In fact, Degree students overcame their uncertainty about the future by making a priority of their desired careers in technology-related fields. It was important to them to realize their professional goals, which might or might not have been reinforced during college.

Some rationalized their uncertainty about the future by weighing the pros and cons of pursuing master's degrees. For example, Megumi (Degree, Central) decided not to look for a job because she knew that she had a minimal chance to obtain a professional job in her field without a master's degree. Although she could not rule out the possibility that she may stop working after she had a child in the future, she wanted to obtain a professional job in technology-related fields. She did not want to work as a generalist, wasting what she had studied in college.

Other participants in Degree category needed certain occasions to remind them of their career interests. Those who engaged in extensive job search activities cited research experience, personal advice from significant others, or the failure of their job search as such reminders. They might not have been clearly convinced of their interests by their experiences in the department. For example, Kazumi (Degree, Western) had to join a research unit to become certain of her decision to pursue a research career in engineering. Kazumi first looked for non-technical jobs because she no longer wanted to work in engineering. However, she seriously started to reconsider her options once she received a job offer:

> Until then, I had no idea what a research unit would be like. I think that I had already done sufficient [name of the field] coursework at that time.
>
> Q: Do you mean that you did not want to study anymore?
>
> Yes. I wonder whether I had grown to dislike [name of the field] because we were taking exam after exam at that time. But research. We study what interests us. We investigate what we don't know. We can change the direction. I didn't know that kind of excitement of research when I was a third-year student.

Degree students perceived that their pursuits were supported within their department, particularly as they proceeded through the program. They became acquainted with men and women who were pursuing similar professional goals and considered male advanced students as role models, despite their different gender. This is in contrast with Work students, who often complained about the lack of information they received regarding the job search process and detachment from graduate students or faculty. For instance, Kei (Degree, Western) cited the discussions with male senior students she met

at her part-time job facilitated her decision to pursue a master's degree. She did not want to miss research opportunities she heard about from them:

> They would say such things as, "There is a student who goes to a conference," "Students in a certain research unit have many chances to do the collaborative work with people in other countries," or "Such and such said that [s]he was going to England." If I enter a master's degree program, I can do what only a graduate student can do. What is more, it is for research.

Degree students seemed content with their exploring their post-college plans as long as their focus was on information regarding work in the research unit and master's level work.

Positive Attitudes toward Pursuing a Master's Degree

Participants in the Degree category, including those who extensively engaged in a job search, often claimed that it was natural for engineering students to pursue master's degrees because it was a prerequisite for professional employment. They considered their undergraduate study preparation for graduate work and perceived some challenge in the graduate work. For example, Sayo (Degree, Central), who heard that the real study starts at the master's level, did not think she had learned enough in her undergraduate program. Those who decided to continue to a master's program believed it necessary to acquire knowledge and skills through graduate study so they obtain jobs that interested them. They were interested in the content of the master's degree program. When selecting a research unit at the end of their third year, Degree students typically considered the research or work opportunities available in that unit (e.g., working with industry, collaborating with researchers in other countries, and traveling abroad for international

conferences) to be important. For instance, Takako (Degree, Western) wanted to conduct research using a machine that could be found only at her school and at no other program in Japan. A limited number of participants considered applying for master's degree programs at different engineering school that attracted them.

In this chapter, I described women's perceptions of engineering and of themselves as engineering students as a reflection of the interactions with others in the department and their respective views. I have also underscored how participants engaged in engineering-related behaviors, both alone and with others, and responded to their perceived challenges. Although women's perceptions and experiences were mostly discouraging, some participants, especially Degree students had some confirming experiences. Finally, I outlined what women engineering students in each group considered in their postgraduate decisions based on their evaluation for engineering work and pursuit of master's degrees.

Chapter 5

DISCUSSION

In this chapter, I will answer the four research questions that were the focus of the study. To remind readers, the four research questions were:

1) In their early final year, how do female undergraduate students at two national engineering schools in Japan describe their engineering identity-related experiences?

2) How did final-year Japanese female engineering students make sense of their experiences in the academic department in relation to their immediate postgraduate decisions and their future career?

3) In what way are Japanese female engineering students' departmental experiences and their understanding of those experiences different for those who go on to master's degree programs compared to those who seek immediate employment?

4) In what ways did Japanese female engineering students consider departmental experiences in their postgraduate decisions relevant to becoming engineers?

After responding to the research questions, I will discuss implications for research and practices before concluding this study.

Women's Experiences in College

In the previous chapter, I have described how women engineering students in Japan engaged in engineering-related behaviors through social interactions with faculty and peers. The development of an engineering identity for these students could be described as a "broken loop" (Burke, 1991); the process was interrupted at various points

based upon input from the faculty, and this largely negatively influenced their engagement in other academic behaviors, including seeking help and working comfortably in a group setting. However, women's challenges in pursuing engineering studies were often ameliorated by their cooperation with other women students.

Based on identity theory, individuals' development of an engineering identity is a consequence of their engagement in engineering-related behaviors through interactions with others (Burke, 1991; Stryker, 1980). Women in this study experienced challenges that inhibited their identity development process forward, which were further complicated by their constrained structural positions in the society. Consistent with my findings, women's dissatisfaction with classroom instruction and negative effects of students' self-perceptions in STEM field have been well-documented (Amelink & Creamer, 2010; Colbeck, Cabrera, & Terenzini, 2001; Seymour & Hewitt, 1997; Vogt, Hocevar, & Hagedorn, 2007). What differs for many of the women in this study is that their engineering identity development is also hampered by the cultural messages they receive as women not to act or assert themselves.

Past studies have typically attributed women's challenges in engineering to others' treatment of them or a conflict between gender identity and professional identity (Hatmaker 2013; Powell, Bagilhole, & Dainty, 2009). However, the present study that used identity theory as framework indicates that women are also responsible for their experiences. Women's development of an engineering identity is the result of their own engagement in engineering-related behaviors and social interactions, which are influenced by their structural position as women, but also differ by each individual's unique behaviors.

The findings suggest that participants' reluctance to approach professors originated, in part, from embarrassment about revealing their inadequacies as engineering students to their instructors. Participants received an "accessibility cue" (Wilson, Wood, & Gaff, 1974) from professors that indicated students were not welcome to approach them. According to identity theory, individuals regard others' feedback as important to the extent that they value the interactions and their relationship with those individuals (Burke & Reitz, 1991). As a reflection of the importance women place on faculty throughout the pursuit of their engineering studies, it is understandable that many female students were discouraged from approaching faculty actively whom they considered "scary." In addition, despite feelings of inadequacy, participants tried to project a positive image to the faculty to shield their self-worth as engineering students. This fear and resultant avoidance of faculty contact has been explained in the literature in Western societies as STEM students' unwillingness to reveal their weaknesses (Seymour & Hewitt, 1997) or undergraduate students' fear to be singled out and required to work harder (Cotten & Wilson, 2006). The issue might be exacerbated by the power imbalance between teachers and students in Japan where individuals defer to others who are their senior. For those in this study, there were significant psychological distances between students and professors stemming from their status differences. Considering that engineering students in Japan are required to engage in a capstone research project in the research unit and are likely to continue their graduate study within the same department if they pursue a master's degree, the participants understandably felt that the stakes were too high to reveal any incompetence.

Although comparisons with men are outside the scope of this study, women perceived themselves to have more challenges in engineering study than their male peers. Even in the current educational practice in engineering schools, wherein many instructors seem to fail to provide students with direction and guidance, men can count on their larger network that includes advanced students and academically high-achieving students. Female students, such as those in this study, whose networks are often limited to a few to several women probably do not have as many resources as men typically do, unless they use experts' help. Women who approached their engineering studies in a similar manner to how they perceived men did (i.e., did not seek out instructors' guidance) seemed to develop their identity differently than men due to their small social networks. Still, women developed different levels of engineering identity depending on their socio-emotional basis of commitment to engineering identity (Burke & Reitzes, 1991), which help individuals to engage in identity-related behaviors.

Interactions with male peers, which started occurring at the applied stage of the engineering program, provided women with opportunities to express their engineering identities and receive feedback on their performance. However, much like the classroom experiences, laboratory work failed to provide the women with an ideal educational setting in which they could actively participate in tasks, receive feedback, and develop sound self-evaluation. Findings of this study corroborate past studies about women's experiences of engineering laboratory work that reported women were discouraged by men's hostile attitudes toward them and competitive behaviors in group settings (Allan & Madden, 2006; Felder, Felder, Mauney, Hamrin, & Dietz, 1995; Du, 2006; Tonso, 1996). Findings from my research especially resonate with Allan and Madden (2006)'s study

that found women experienced discouraging and marginalizing interactions with their male peers.

Findings suggest that the learning environment was partially responsible for the women's negative experiences. Although this study did not compare women's experiences based on the proportion of women in the group, it seems that their token status intensified their challenges. The women understood that their challenges were due to fewer numbers of women in the group; by lacking a critical mass of women, they had little influence over the group dynamics. In addition, participants' lack of understanding of their male peers' competency in engineering contributed to their difficulties.

The increased comfort level over years can be explained as a result of students' development over the years. As college students gain more experiences while working with other people on the job and in classes, their comfort level increased regarding group work (Colbeck, Campbell, & Bjorklund, 2000). Expectation states theory asserts that individuals who obtained information about the task-relevant aspects of individuals with whom they worked assumed a more accurate performance expectation of others (Wagner & Berger, 1997). In engineering, this information is especially important to women who have lower status characteristics for engineering work (Correll, 2004). Such information would enable them to realize their full potential and to be recognized in accordance with their competency.

Despite the lack of interactions with their faculty and male peers, many women did informally interact with their female peers. These interactions facilitated their development of an engineering identity. Moreover, female peers provided the women with assistance in engaging in engineering-related behaviors, and they served as

alternatives to individuals with whom the women had difficulties approaching. Especially during the early years of the program, when female students were socially isolated within the department and had few opportunities to engage in activities as engineering students, they seemed to benefit from their interactions and relationships with female peers. Joint activities that involved receiving performance feedback and assistance in understanding the course material served as indispensable opportunities for women to obtain self-verification as engineering students. Their relationships further aided them in making meaning of their experiences at later stages (e.g., in the laboratory group, within the research units) when women lacked female peers. Collaboration with their peers contributed to engineering women's survival in an environment in which they were isolated from the larger community. These findings corroborate those in studies that reported the positive influence of women's perceived initial social supports from peers on their educational outcomes in STEM (Rosenthal, London, Levy, & Lobel, 2011; Szelenyi & Inkelas, 2011).

During the identity development process, where individuals adjust their behaviors in relation to their identity standard based on performance feedback, individuals on the other side of the identity relationship (i.e., role-based others) play a pivotal role in the exchange of identity-related resources (Burke, 1991). Role-based others can also serve as the socio-emotional basis of commitment toward an identity through interactions and relationships (Burke & Reitz, 1991). The role of peers in college students' degree aspirations (antonio, 2004; Wallace, 1965) has been documented along with other outcomes such as adjustment to college and persistence toward graduation (Pascarella & Terenzini, 2005). In these studies, peers' roles have been conceptualized as

social supports or the climate. The present study offers a new way of conceptualizing peers: informal role-based others with whom women could exchange both positive and negative identity-related resources.

Lowered Self-Evaluation as Engineers

At every stage of their undergraduate careers, women in my study made a low self-evaluation as engineers. They perceived inadequacies through formal and informal interactions with faculty members and their peers. Again, women's lower status characteristics regarding engineering work and subsequent lack of power in interactions and forming networks led to few opportunities to receive verification as engineering students (Stryker, 1980). Women had few opportunities to adjust their status to a more robust engineering identity in the first place because they did not have as much feedback to compare due to their social and academic isolation from faculty and male peers.

In a context wherein women are not easily validated as engineering students, women's own behaviors of deference to and avoidance of others to protect themselves further limited their opportunities for self-verification. For example, the women engineering students' passive participation in classes and infrequent, selective contacts with faculty members outside the classroom might have been necessary (in this way, they avoided making any negative impressions on professors), but these behaviors were counterproductive because they limited the opportunities to prove their engineering acumen and identity to those who could further reinforce it. Similarly, women's lack of direct involvement in laboratory work, in which they deferred to male students and accepted their limited role in the group, restricted their opportunities to learn by doing the work and consequently made them dissatisfied with group work.

Furthermore, participants developed a low standard for their engineering identity over the years in two ways. First, women perceived high expectations from faculty in formal encounters, which seemed unattainable. Second, women internalized the male students' expectations of them as individuals who did not participate actively and perform well in the laboratory work. Although male students were not in a position to evaluate their performance, many participants sensed that their male colleagues did not think they were skilled enough to be engineers, and thus, lowered their engineering self-evaluation. These findings corroborate past studies that identified positive relationships between educational experiences (e.g., teaching practices, student-faculty interactions, and peer relationships) and students' self-concepts and educational and career aspirations (Amelink & Creamer, 2010; Colbeck et al., 2001; Pascarella, Wolniak, Pierson, & Flowers, 2004; Vogt et al., 2007).

From the standpoint of identity theory, the quantitative aspect of one's interpersonal interactions and relationships is obviously important to identity development. Those who engage more often with others and maintain relationships with more individuals benefit from a broader and stronger basis of commitment (Burke & Reitz, 1991) and also gain more opportunities to develop a strong identity and enact their identity. This appeared to be the case in this study as well, as those women who became more comfortable collaborating with male peers through laboratory work had a stronger engineering identity and were more likely to continue to pursue a career as an engineer post-graduation.

Yet, I contend that the quality of interactions and relationship is also important for female students to engage in behaviors necessary for engineering identity

development. Most participants were very selective in interacting with faculty to avoid negative input to their identity. Participants also considered that the extent to which they participated in group work depended on the individuals with whom they worked. Findings of this study indicate that it is necessary for individuals in a weaker social position to ensure the quality of social interactions beforehand because they do not have power to control the outcomes of the interactions (Burke & Stets, 1999). Women seemed to choose individuals with whom they relatively easily exchanged engineering-related resources including a meaning of engineering students.

Meanings of Being Women in Engineering

Although participants often experienced poor classroom instruction and a sense of invisibility in the department, only some admitted these experiences were due to their gender. The participants' perceptions and behaviors in the department indicate that the environment was not particularly welcoming to them as women. Past studies that examined college women's experiences in male-dominated STEM fields in Western countries found that some women perceived subtle behaviors that manifested as micro-inequalities between men and women in and outside classrooms (Allan & Madden, 2006; Colbeck et al., 2001; Vogt et al., 2007).

On the one hand, participants found it hard to approach faculty members, who are almost always male, even for course-related questions; however, no participants explicitly claimed that their gender or that of their professors played a negative role in their interactions in and outside the classroom. Further, participants did not report that faculty discouraged women from continuing to study engineering (Seymour & Hewitt, 1997). It is not surprising that women were unaware of their gendered experiences during

their interactions with faculty members. This situation is similar to that in the United States where women engineering students' accounts of gendered interactions are often more pronounced or sometimes limited to their exchanges with peers at the undergraduate level (Allan & Madden, 2006; Colbeck et al., 2001; Seymour & Hewitt, 1997). Participants who had recently entered the research unit may not have had enough opportunities to directly interact with faculty members and/or realize the gendered aspects of their experiences. They may realize such aspects once they interact more frequently with faculty members and graduate students in a research unit, as past studies in STEM have reported (Darisi, Davidson, Korabik, & Desmarais, 2010; Ferreira, 2003; Koinuma, 2009).

On the other hand, participants perceived that gender mattered in the interactions with their male peers. Participants attributed this to their minority status and different social networks. Also, participants were at least aware of the link between engineering work and students' gender. The finding that most participants did not actively approach male students outside classrooms might be interpreted that they avoided interactions with male peers because they anticipated their male peers would challenge their abilities (Hirshfield, 2010).

Participants in this study noticed that instructors behaved differently in individual encounters than in the classroom, where the majority of students were men. In some cases, participants even interpreted of these gender-based experiences as positive. Women's positive experiences with faculty outside the classroom (in the limited times they did engage with faculty) was consistent with Powell and her colleagues' study (2011) that reported that women received more academic help than men in engineering

classes. It remains to be examined whether students' perceptions of being treated differently stem uniquely from a male-oriented engineering culture that does not consider women as full members or from the faculty's attitudinal differences in smaller, more personalized settings. Women seemed to receive contradictory messages from faculty members as engineering students. Whereas women, as a rarity in engineering, received welcoming messages in individual encounters, they received negative messages in the classroom that they were novice learners. Because most women's contacts with faculty were limited to classroom, they were largely discouraged as learners. Although it is comforting that women did not perceive much discriminatory treatment in interactions with faculty members, the entirety of their experiences and acceptance of differential treatment indicate they may have other negative consequences for their self-worth and engineering identities (Powell et al., 2011).

Regardless of participants' understanding, the findings of this study indicate that these women's experiences in engineering are gendered; they behaved as they were expected as women and perceived and understood the environment in a gender biased way. It is significant that these experiences were shared in a study context that women were asked to explain their college experiences that informed their postgraduate decisions.

Characteristics of Degree Students' Experiences

As an answer to my third research question, I will discuss characteristics of participants who planned to pursue a master's degree (Degree students). Overall, both Work students (participants who planned to start working immediately after college) and Degree students experienced engineering classrooms negatively. Only some Degree

students actively engaged in behaviors that involved other individuals. As they progressed through the program, however, Degree students held more positive self-evaluations, engineering identities, and sense of belonging.

Assertiveness and Intentionality in Behaviors

Some participants engaged in identity-related behaviors in social interactions with others more actively and intentionally than others (e.g., seeking help from faculty, working together in groups). Because interactions with others within the department provided students with opportunities to act and get recognized as engineering students, it is understandable that those who actively approached others were often Degree students who we would expect to have a stronger identity. Identity theory argues that when a certain identity is more important than other identities, individuals are likely to engage in behaviors that are related to that identity and understand their experiences in relation to that identity because they seek opportunities to enact their identity (Stryker, 1980). The findings from this study appear to support this in regard to strengthening engineering identity. Also, the rareness of individuals who actively engaged in social interactions indicates women's difficulties in engaging in identity-related activities even among those who intended to pursue master's degrees. Many women opted to use other means to develop their engineering identity.

These assertive participants were also aware of the consequences of their behaviors and attempted to influence others' perceptions of themselves. For example, more assertive participants were those who presented themselves as serious students to faculty members and good colleagues to their peers in the group. Identity theory assumes that individuals negotiate with others regarding the meanings of identity and behaviors

(Burke & Stets, 1999). In fulfilling interactional goals, understanding others' expectations and/or having power to influence others helped individuals. Even though exceptional students often had some power to express their commitment to engineering career by their plan to pursue a master's degree, they still behave in accordance with the others' expectations as women engineering students.

Interestingly, there was little variation regarding participants' experiences with classroom instruction, but there was much variation regarding their interactions with the faculty outside classrooms and interactions with male peers in laboratory work. Although students were not able to choose aspects of the formal study environment, they had more discretion in informal settings regarding how and in what environments they should study. As previously mentioned, those most likely to engage with others outside the classroom were in the Degree category; these activities seemed to be extremely valuable in establishing a stronger identity.

Positive Self-Evaluation as Engineers

Other than several exceptional students, participants in the Degree category did not engage in engineering-related behaviors very actively. Yet, those who planned to pursue a master's degree to fulfill their professional goals interpreted their overall experiences relatively positively and had positive perceptions of self as future engineers. Degree students were able to remain optimistic about their abilities despite the absence of confirming evidence. Although it is possible that these students actually performed well and thus did not need other validation, there may be other reasons for their optimistic attitudes.

Positive perceptions of self might be a reflection of their engineering identity or identification with engineering culture. Those who were determined to pursue master's degrees likely perceived fewer obstacles in identifying with other engineering students and thus had less trouble seeing themselves as future engineers. Having a career plan is relevant to the development of an engineering identity (Meyers, Ohland, Pawley, Silliman, & Smith, 2012). Thus, it is understandable that Degree students interpreted their experiences more positively than Work students.

The present study does not clarify which social psychological factors may be involved in these differences in self-evaluation and engineering identity. Social psychological concepts, such as resilience, stereotype management, and self-efficacy beliefs, seemed to be informative for understanding Degree students' positive interpretations (Cech, Rubineau, Silbey, & Seron, 2011; McGee & Martin, 2011; Vogt et al., 2007). Vogt and his colleagues (2007), for instance, reported that engineering students' level of self-efficacy in engineering work explains their level of engagement in academic behaviors, including efforts and help-seeking. As researchers have demonstrated the link between these concepts and students' motivation and/or behaviors, it may be reasonable to assume that participants with a high level of self-efficacy in engineering were able to maintain their motivation for engineering and expend effort, even when they did not actively interact with others.

It is important to consider the findings of this study within the Japanese context. In Japan, students who are selectively admitted to a college-level engineering program have better chances to graduate and are expected to advance to master's degree programs in a department where they pursue bachelor's degrees. In this context, therefore,

perseverance for women and men is expected, unlike the situation for many students in U.S. engineering programs (Seymour & Hewitt, 1997). Under this less-threatening environment, individuals with strong interests and determination may be more optimistic about their academic pursuits than their U.S. engineering peers.

Meaning of Going on to Master's Degree Programs

Findings from this study elucidate the development of engineering identity. First, acquisition of an engineering identity involved changing students' perception of their environments and attitudes toward role-based others. As previously discussed, female students' initial experiences with faculty in formal settings did not vary but their ultimate perceptions of their overall experiences and engineering identities differed.

Second, individuals need to have a strong identity to act in the first place, but they also need to act in order to maintain and develop the identity. As compared to Work students, Degree students might have had more ascribed resources to use to develop their engineering identity (e.g., a clearer career plan, awareness of the necessity of a master's degree, interests in the study, and support from significant others), which helped them decide to pursue a master's degree. Degree students also acquired more new resources (e.g., informal ties for academic purposes, good academic understanding, and a sense of membership) by actively engaging in engineering-related behaviors. Given most participants in the Degree category were unable to behave assertively, good performance and individuals' desire to work in engineering appeared to play an important role in facilitating their action, which mirrors research about access to and persistence in graduate education in STEM (Leslie, McClure, & Oaxaca, 1998; Sax, 2001).

When students discussed having positive experiences in their academic programs, they often described more than one. Individual differences in identity are thus the reflection of accumulation of identity-related activities (Burke, 1991). Although positive behaviors were a reflection of individuals' engineering identity salience, there were other factors that contributed to their overall experiences. This is to say that individuals' interests in engineering do not guarantee active and successful engagement in engineering-related activities. Rather, as discussed above, whether women successfully enacted their identity or acquired new resources partly depended on others with whom they interacted.

Women's Postgraduate Decisions

To answer research question 4, I explained the extent to which Japanese women have considered their departmental experiences while making postgraduate decisions concerning careers in engineering and the pursuit of master's degrees. Participants' decisions regarding whether to pursue a career in technology-related fields were negatively informed by their college experiences in terms of their aptitudes in the field, the amount of work required, the work style, and the culture of the fields. Those women who planned to start working full-time (Work) emphasized non-college related factors as the main reasons for not pursuing master's degrees. Although they did not state any negative experiences within their respective departments as reasons for not pursuing master's degrees, they seemed to be informed by their experiences in several ways. First, those who planned to voluntarily leave the field due to their sense of ineptitude claimed that the experiences in the laboratory in which they directly worked with others led to feelings of inadequacy. This finding indicates that there might be social reasons for

women's departure, in addition to their diminishing interests (Amelink & Creamer, 2010; Baker, Tancred, & Whiteside, 2001).

Second, most Work students who left the field as a result of weighing the pros and cons of working as professional engineers claimed that their primary concerns were based on the perceived amount of work and work-style. Participants' observation of male students' working overnight and behaving competitively informed them that they might not be well-suited to work in the engineering field, despite their current interests. These feelings were also largely rooted in their considerations of having children in the future. In this regard, the relationship between women's persistence in STEM fields and their orientation toward family has been reported in the United States (Ferreira, 2003; Hawks & Spade, 1998; Sax, 2001; Seymour & Hewitt, 1997). Work students' experiences in their majors played a role in their decisions to some extent, primarily helping them envision a future self, who faces significant challenges balancing family life and engineering work. Their experiences appeared to have taught them that pursuing an engineering career could be a costly affair, especially if they possessed a traditional gender ideology.

Third, participants further developed a negative image of graduate study based on the culture of the department. Regarding the pursuit of a master's degree, the term "culture" refers to not only the masculine culture in the field but also the culture of the department in which individuals work. In addition, since continuing in a master's degree program most likely means working in a department with which they were already familiar and/or uncomfortable, negative attitudes about graduate work may have had more to do with the departmental climate than the actual engineering aptitude required

for graduate work. This seems to be different from the United States where engineering students have more options for their master's degree programs (Seymour & Hewitt, 1997).

Finally, women are more likely than their male peers to submit to social pressure to start working after graduation in Japan. Thus, a master's degree program that requires 2 or more years after completing undergraduate studies is not an attractive choice for women. All of these findings, coupled with the cultural expectations for women in Japan, suggest that anticipatory socialization for engineering professions, which often starts before students enter college and then is to be further reinforced in engineering schools in Japan, is hindered by traditional gender norms for women in Japan. It is especially concerning that those who want to work in engineering often decide not to pursue a professional career because they believe that graduate study is unnecessary.

Implications

Research Implications

This study compares female engineering students' college experiences according to their postgraduate plans only; there were no data specifically collected to measure engineering identity, other than to understand whether such an identity exists for participants. Future research should measure the strength of individuals' engineering identity in order to have a more complete understanding of the identity differences between students who choose to attend a graduate program and those who do not.

This study examined both the interactional and affective aspects of basis of commitment to engineering identity (Burke & Reitz, 1991). The former seemed to relate to participants' identity salience (i.e., those who were interested in engineering could

actively interact with others), the latter less so (i.e., those who had male friends were not necessarily committed to an engineering career). I did not systematically examine how participants' collegiate experiences or their decisions to pursue a master's degree differed according to the nature of their relationships (e.g., acquaintances, friends in a membership group, significant others). As a result, I recommend that future research focus more specifically on the role of the nature of relationships in women's experiences in college and their post-college decisions.

Given that this study relied solely on self-reported data, I can make only limited claims about the role that participants' level of understanding of engineering content played in their experiences and interpretations. However, this study's findings suggest that the level of understanding might have played an important role in the realization of identity-related behaviors such as approaching faculty and participating in group work. Examining the influence of grades is common in quantitative studies on engineering students' persistence or college graduates' participation in graduate education (Crisp, Nora, & Taggart, 2009; Jackson, Gardner, & Sullivan, 1993; Malcom & Dowd, 2012). However, few qualitative studies of women's experiences in engineering have paid attention to level of understanding or grades, except for Hughes (2011), who examined how women in engineering interpreted their academic performance differently according to their intention to persist. Future qualitative research should consider women's sense of understanding or grades to enrich our knowledge of women engineering students' experiences and career pathways.

This study has limitations in concluding that observed challenges were women-specific because it did not compare women's experiences with men's. Still, the literature

on teaching practices in STEM in the United States indicates the gender difference in terms of the aspects students considered problematic (Colbeck et al., 2001; Heller, Beil, Dam, & Haerum, 2010; Seymour & Hewitt, 1997). Future studies should compare men's and women's experiences and identify women-specific experiences. In addition, future studies on women's experiences probably would benefit from including men's perceptions of women's experiences. In addition to hearing from male students, instructors could provide useful insights on how students take classes differently and how their levels of understanding and their comfort with faculty play into their interactions.

Regarding women-specific experiences, the interview design of this study might not have allowed participants to reflect fully on gender factors in their interactions with faculty or male peers. I only inquired globally at the end of the interview whether their gender played a role in their college experiences and did not specifically inquire about their perception of gendered aspects of their contacts with faculty members or male peers. In addition, I did not indicate in recruitment materials that the purpose of the research was specifically focused on gender or equity. What participants thought of as "women-specific" usually did not include their femininity or being treated as objects (Allan & Madden, 2006). Women might have had more experiences to share if I had advertised the study differently or had asked different interview questions with a more purposeful focus on gender.

This study did not primarily deal with the role of gender in women's experiences or women's management of their gender identity. The use of identity (control) theory and expectation states theory does not focus on personal identity characteristics such as gender. Yet, some findings reveal that gender is an important factor in women's

experiences in engineering. Thus, future research should analyze these data using a gender or feminist framework. In addition, other researchers who study Japanese women may consider constructing studies to focus more intentionally on gender and equity.

Furthermore, it would be productive to examine the meaning of women's engagement in socio-emotional or expressive behaviors, especially in groups, which seemed to be an important mechanism for women seeking to gain acceptance from their peers. First, it is important to understand what individual characteristics facilitate women's engagement in these behaviors in interactions. Second, we would like to understand the intentionality of these behaviors. Women might not have been aware of the strategic meaning of their behaviors but only thought it necessary to follow other's expectation. In addition to individual factors, there may be environmental factors. Because the success of gender performance depends on the other individuals in the interaction (West & Zimmerman, 1987), observing group interactions and interviewing group members about their expectations and perceptions of socio-emotional behaviors could be informative, and would reveal aspects of which the participants might be unaware (Sallee, 2011; Tonso, 1996, 2006).

This study did not compare students' experiences across departments. Still, I acknowledge that women's learning environments differ by departments. Thus, I recommend examining women's experiences in a certain department only to consider the department-specific context. In addition to the department's discipline, history, and culture, the gender composition of its faculty and staff and research activities might influence women's experiences. Engineering schools in Japan have been encouraged to hire more women faculty and staff (Gender Equality Bureau, Cabinet Office of Japan,

2012). The department's commitment to increasing the number of women faculty, staff, and graduate students might influence the departmental climate, and subsequently female students' experiences. Similarly, departments that offer doctoral degrees, such as those in the current study, might provide more academically-oriented environments and chances to understand the research work with students than those that offer master's degrees only.

Although numerous studies of women's experiences in STEM fields have been conducted outside the United States, comparative perspectives are often missing. This study can only compare the Japanese context to the extant literature, not to a comparable case in another country. Existence of commonalities that have emerged in my study with the extant literature suggests that there are commonalities in the academic experiences of women engineering students, including dissatisfaction with classroom teaching and difficulties in group work. Conducting a specific comparative study would provide even more evidence of similarities and differences and might lead to cooperative efforts across boarders to understand problems and create and employ strategies to improve women's educational experiences.

Practical Implications

Several practical implications can be drawn from this study's findings. First, we should improve women's formal learning experiences, especially in the first year. Although participants did not explicitly interpret their formal learning experiences as chilly or women-specific, some features of their classroom experiences were similar to women's experiences reported in the literature (Allan & Madden, 2006; Du, 2006; Powell et al., 2009, Vogt et al., 2007). Despite the absence of such claims, it is still noteworthy that study participants volunteered to report troubling experiences with faculty in formal

instructional settings that seemed to inhibit their learning, especially in the early years. The problem might not be the gendered nature of engineering but poor teaching and the women's responses to it. The findings suggest that the teaching in the two engineering schools examined in the study appeared to be ineffective, at least in terms of the widely espoused principle of student-centered learning. It is thus understandable that the participants were passive and dissatisfied with their experiences in formal instructional settings.

There seems to be room for improvement on the part of the faculty, although some engineering professors might think that the women should participate more actively in class and become more assertive by asking questions or requesting a change in teaching practices. Engineering professors, who are hired for their research accomplishments, typically lack training as teachers and thus, need resources and professional development opportunities to become better teachers. Because different teaching practices in engineering contribute to men's and women's confidence to pursue engineering careers (Colbeck et al., 2001), professors in engineering should become more cognizant of women's perceptions of their teaching practices and attitudes in class. As this study shows, professors need to be aware that the gender composition of the classroom affects both their teaching behaviors and students' in-class participation (Canada & Pringle, 1995; Cornelius, Gray, & Constantinople, 1990; Tatum, Schwartz, Schimmoeller, & Perry, 2013). Because poor classroom experiences impede positive out-of-class interactions and, subsequently, the development of engineering identity, instructors' intentional efforts to teach effectively through class design and the use of

good pedagogical techniques might be necessary. It would not only help students understand the content but also encourage them to more actively engage in their learning.

Second, women should be able to engage in laboratory work that is more intentionally designed to facilitate students' learning. This study offered many practical implications for laboratory work. The most basic concern is that groups typically include just one woman. Given this study's findings, which corroborate those of existing studies regarding gender composition of group work in college (Allan & Madden, 2006; Colbeck et al., 2000; Tonso, 1996), instructors should assign at least two women to a group. Studies that examined the effectiveness of collaborative work in college suggest that there is no single ideal way of composing groups (Colbeck et al., 2000; Hsiung, 2012). However, more attention should be paid to the group composition. Instructors should be more cognizant of the challenges that some women may have. If it is inevitable to have only one woman in groups, paying attention to assignment of a leader may mitigate women's difficulties because female students' success in the group work seems to depend on male students' responses to their actions (Tonso, 1996, 2006). Also, including more advanced students or graduate students who have more experiences in the group work as facilitators might improve group dynamics (Colbeck et al., 2000). Furthermore, formally assigning students with certain roles in advance may facilitate women's chances of participation by increasing their legitimacy (Burke & Stets, 1999).

In addition, instructors should take more direct, intentional actions to influence group dynamics through guidance, monitoring, and feedback. Although college students might be able to work collaboratively based on their own previous experiences in and outside academia (Colbeck et al., 2000), students benefit from guidance about laboratory

work that involves working in a mixed-gender group in and outside the classroom (Colbeck et al., 2000; Natishan, Schmidt, & Mead, 2000). Students should be encouraged to work cooperatively and increase their awareness of gender differences in working styles and modes of communication (Conferey, 2000; Wolfe & Powell, 2009). In addition, instructors should monitor how students work on tasks and interact at least inside the classroom.

Although this is a speculative assertion because the extent of instructors' involvement was not systematically investigated in this study, the students seemed to be left alone during the laboratory work, as was observed in previous studies (Allan & Madden, 2006; Amelink & Creamer, 2010; Du, 2006; Seymour & Hewitt, 1997). This is problematic, given that students tend to assume a certain role only once their position in the group is established (i.e., role interdependency) (Colbeck et al., 2000). If we leave students to decide their roles, women are more likely either to assume a socio-emotional role that is unessential to the task or to not participate. Last, students should receive proper feedback and evaluation from the expert in the field (i.e., the professor) to avoid excessive reliance on self-ratings, which people often do when they lack objective criteria (Festinger, 1954). It might be necessary to provide information on students' academic standing before starting the laboratory work. Having accurate information on other's task competency would encourage women to work with male students more assertively.

Findings were consistent with past studies reporting that working in a mixed-gender group was challenging to most women students, especially at first (Du, 2006). Because the work in the field of engineering inevitably involves collaborative work, undergraduate programs should offer opportunities to learn to become good

collaborators. This study indicates that the laboratory work, a primary opportunity for many students to interact with their fellow students, assumed many functions, including socialization, and thus did not provide an ideal learning environment. Considering engineering students' tendency not to socialize beyond their membership groups (Case, 2007) and the long-term benefits of working in a group, it might be helpful for engineering students to start working in the laboratory or in group at an earlier point in their studies. Such opportunities will confirm their understanding of course materials and help them integrate successfully with their peers.

Finally, this study has implications for guidance for engineering study and work. Findings of this study indicate that women had challenges especially in the early stage in forming ideas about engineering study. Students should be taught to become more independent as learners. Engineering schools should teach students as soon as they start an engineering program what college-level learning is and how students should study engineering. Allie et al. (2009) recommended that engineering schools should teach the implicit knowledge, "discursive identity", with the help of experts on teaching and instructors in other disciplines.

The findings that the participants' perceived lack of access to information regarding careers in engineering contributed to their decisions not to pursue master's degree suggests that more women might pursue an engineering career if they had sufficient information and opportunities to explore possible options in the field. Women's challenges in taking necessary actions, including collecting information for graduate education and seeking assistance have been reported (Baker et al., 2002; Seymour & Hewitt, 1997). The issue might be a result of the small size of women's network and

perceived quality of the content of available information. Women, especially those who perceived they were different from typical engineering students, might have considered information from male students and faculty unreliable and department-specific. If this is the case, engineering schools need to pay attention to the way they transmit information. Compared with women in Western countries, women studying in Japan, where male and female social spheres are largely segregated, might need to receive information from other women to a greater extent in order to perceive the information as relevant to themselves. Considering the dearth of women faculty, utilizing women staff and graduate students may meet these students' needs.

Furthermore, engineering schools should provide opportunities for students to become informed of diverse career options in engineering. This study indicates that women had difficulty forming an idea of what they would do in the work in technology-related fields even late in their third year when they decided their postgraduate plans. This lack of understanding seemed to increase their worries about their ability to work while managing families. The literature has documented the importance of role models for women pursuing a career in STEM (Amelink & Creamer, 2010; Capobianco, 2006; Seymour & Hewitt, 1997; Zeldin & Pajares, 2000). Considering this study's finding that participants did not necessarily view encounters with more matured women in their field positively, it is important that female students who consider gender important to their career choice are provided with women role models in an encouraging way. In addition to working professionals who are already accomplished, students in advanced classes or graduate programs could function positive role models.

Women in Japan seem to face dual obstacles while pursuing an engineering career. They need to have an interest in a profession that is considered inappropriate for women socially and to be comfortable with pursuing master's degrees, which is still uncommon in Japan. To increases the number of female engineers in Japan, we must eliminate the obstacles specific to women. It may be necessary to change hiring practices that demand a master's degree before entering the workforce, as well as to change women's perceptions about their options after college. The current process of individuals deciding the field and career level before they graduate from college leaves little flexibility to explore possibilities. Such opportunities were especially important to individuals who start working in technology-related fields without pursuing master's degrees to advance their careers.

Conclusions

Recent efforts in Japan to increase the number of women in STEM fields have focused on recruitment of high school students (Bureau of Council for Science and Technology Policy, Cabinet Office, Government of Japan, 2011). Although the recruitment of more female students for undergraduate programs is the most apparent solution to the underrepresentation of women in engineering (MEXT, 2003; Osumi, 2006), the recruitment efforts seemed to be based on the optimistic view that those who entered undergraduate programs in engineering would remain in the field. These efforts will be ineffective if women continue leaving the field after obtaining a baccalaureate degree.

This study reports that women engineering students, even those who decided to pursue a master's degree, lacked convincing undergraduate experiences. Considering the

industry's preference of hiring people with master's degrees for professional positions, it is important to encourage women to pursue them. To enable women to do this, engineering schools should ensure women's satisfaction with their undergraduate experiences and their development of an engineering identity. In this way, women will persist in the field throughout their undergraduate and graduate education and professional work.

Researchers should investigate undergraduate experiences of women who do not persist in STEM after graduation. Although past studies have noted the population, it has not been the subject of research. The research has instead focused on the characteristics of students who leave the field before graduation or who continue to pursue a STEM career after completing their bachelor's degree. This study, which compares women who decided to pursue professional employment in engineering through a graduate degree program with those who did not, provides a more nuanced picture of similarities and differences among women, especially regarding their undergraduate experiences and perceptions of pursuing a career in engineering. Although it is complicated and difficult to distinguish these groups, continuous efforts to understand the difference is necessary to help us understand what colleges can do to increase the number of women graduates who continue to pursue a professional career in engineering.

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Appendix A: Letter for Permission (English)

Masako Hosaka
306 Hitt St. #2G
Columbia, MO
65201
e-mail:
mhwbd@mizzou.edu

To Whom It May Concerned:

I am a doctoral candidate who is studying higher and adult continuing education in the department of Educational Leadership and Policy Analysis at the University of Missouri-Columbia. I am writing this letter because I would like to ask you for permission to recruit female fourth-year students at your school for my doctoral dissertation "Japanese Female Engineering Students' Postgraduate Decisions to Pursue Graduate Education: The Role of the Academic Department in Informing Their Fitness in the Field."

As you may be aware, women's underrepresentation in engineering is an important policy issue in higher education. Although many women in national engineering schools go on to master's degree programs, the proportion of women who attend master's degree programs is still lower than that of men, according to the data from the Ministry of Education, Culture, Sports, Science and Technology. More women than men choose to obtain a job immediately after receiving a baccalaureate degree. The purpose of this study is to understand what role the academic department play in informing Japanese female engineering students' decisions after college. The intended benefit of this study is a better understanding of Japanese female engineering students' experiences of deciding their postgraduate plans, which will contribute to the improvement in undergraduate education and higher education policy making.

This study will be conducted under a supervision of my faculty advisor, Dr. Jennifer L. Hart, with an approval from my dissertation committee and the University of Missouri-Columbia's Institutional Review Board (IRB). Participants are recruited from two to three engineering schools.

I am planning to recruit 10-15 female fourth-year engineering students at your school as soon as I obtain a formal approval from the IRB. I will interview participants for 60 minutes in June and July on the date when it is convenient to each participant. I will ask participants how they have made their plans after college, what they have experienced in college, especially in the department, and other experiences and information that have informed of them in their decision making process. Interviews will be recorded and transcribed with each student's permission, and analyzed qualitatively. If you permit, I will ask you or your designated individuals to discuss a specific recruitment method.

My faculty advisor's contact information is: Educational Leadership and Policy Analysis, 202 Hill Hall, the University of Missouri-Columbia, hartjl@missouri.edu, or (573) 882-4225. The contact information of the University Missouri-Columbia's IRB is: 483 McReynolds Hall, the University of Missouri-Columbia, (573) 882-9585, or umcresearchirb@missouri.edu.

Sincerely,

Masako Hosaka

Appendix **A**: Letter for Permission (Japanese)

＜大学名＞
工学部長　＜工学部長名＞　様

平成 21 年 5 月 15 日

ミズーリ州立大学大学院
教育政策・リーダーシップ分析学科
博士課程　保　坂　雅　子

拝啓

私は、アメリカ合衆国ミズーリ州立大学大学院において高等教育学を専攻している学生です。この度、私の博士論文研究『日本における女子工学部生の卒業後の進路に関する意思決定』のために、貴学部におきまして、女子大学生を対象とした面接調査を行わせて頂きたく、お願いの文書を送らせて頂きました。

工学部に限らず、理科系の学問分野におきまして女性の進出は遅れております。日本の国立大学工学部の場合、女性が学部生全体に占める割合は１―２割程度と少なく、修士課程に進学する率も男性に比べて低いのが現状です。近年、女子中高生の理系進路選択への支援や、女性研究者への支援に関する取り組みが行われています。このような取り組みが有効に行われるためにも、工学教育にとって一般化しつつある修士課程への学士課程からの接続に関する理解が深まることが重要であると言えます。

この研究は、国立大学工学部の４年次に在籍する女子大学生がどのように卒業後の進路を決定しているのかを、大学院に進学するかどうかという違いに焦点を当て、面接調査により明らかにすることを目的とするものです。先日、私の指導教官であるジェニファー・ハート助教授を始めとする４名の教官会議で博士論文のための研究として行うことが許可されました。研究に当たっては、私の自宅が<自宅住所＞にあるという個人的な事情から、貴学部及び近隣大学工学部の学生に参加をお願いすることにしました。可能でしたら、貴学部から１０名から１５名程度の方に、参加して頂ければありがたいと考えております。

簡単に研究計画を紹介させて頂きますと、６月上旬に参加者を募集し、６月中旬から７月末にかけて、予め設定した複数の日時のうち、参加者の希望する日時に１時間半以内で面接調査を行います。面接では、進路選択の経緯を中心に工学部学生としての学習経験や学生生活、職業観などに関し質問させて頂きます。本人の許可を得て録音した面接内容は全てテープに起した上で質的な方法により分析します。

ミズーリ州立大学では、人を対象とした研究をするに当たっては、大学研究倫理委員会から認可を得ることとなっております。その手続上必要な書類のために、＜学部長名＞に、私が貴学部の女子大学生に面接調査への参加を募集することへの承諾をお願いした次第です。承諾して頂ければ、研究倫理委員会に申請し、認可を得た上で、改めて貴学部で必要な手続きや具体的な参加者募集の方法について、＜学部長名＞、あるいは担当者の方とご相談させて頂きたく存じます。お返事をメールあるいは電話で頂け

れば幸いです。なお参考のために、学生さんを募集するための文書（案）を添付させて頂いておりますのでご検討下さい。

保　坂　雅　子

連絡先
＜自宅住所および連絡先＞

Appendix B: Recruitment E-mail (English)

Dear Japanese Female Engineering Students:

I am conducting this study for my doctoral dissertation as a doctoral candidate in the Educational Leadership and Policy Analysis in the University of Missouri-Columbia under the direction of Dr. Jennifer L. Hart.

I would like to ask you to consider participating in my study, "Japanese Female Engineering Students' Postgraduate Decisions to Pursue Graduate Education: The Role of the Academic Department in Informing Their Fitness in the Field." The purpose of this study is to understand the role of the academic department that influences Japanese female engineering students' decisions after college: going on to master's degree programs or obtaining a job. I will interview approximately 20 to 30 fourth-year female engineering students in the first semester of the academic year 2009. The final analysis will be a description of Japanese female engineering students' decisions. My hope is that the study will contribute to improved understanding of challenges and constraints in women's postgraduate decisions.

If you choose to participate in the study, you will be interviewed individually once in the first semester of the academic year 2009. The meeting lasts for approximately 90 minutes, including an interview and explanation of an informed consent. The interview itself last for approximately 60 minutes. I will mainly ask you how you have made your plans after college. I will also ask you what you have experienced in college, especially in your department, and other experiences and information that have informed of you in the decision making process. Interviews, which will be conducted in Japanese, will be audio recorded and transcribed for analysis. You and your college will not be identified by name in the published findings or in oral presentations. After the research is complete, you are more than welcome to review the results.

I will be contacting you to set up our interview as soon as I hear from you. Please indicate your name, department, and convenient days of the week in the e-mail. If you have any questions, please contact me at mhwbd@mizzou.edu. Thank you very much for your considering participating in the study.

Sincerely,

Masako Hosaka
Doctoral Student
Educational Policy and Policy Analysis
University of Missouri-Columbia

Appendix **B**: Recruitment E-mail (Japanese)

○○大学工学部４年生女子の皆さんへ

『女子工学部生の卒業後の進路に関する意志決定』に関する研究について
（面接調査への参加のお願い）

この度、○○工学部長の許可を得て、４年生女子の皆さんに対し、私の博士論文のための研究を目的とした面接調査への参加をお願いさせて頂くことになりました。この研究は，工学部女子学生の卒業後の進路に関する意志決定に関わる要因を、特に大学院に進学するかどうかという点に注目して、教育社会学的に明らかにすることを目的としています。それにあたって、４年生である皆さんに個別面接を行い、そこで得たデータを用いて質的に分析することにしています。研究活動や大学院進学のための準備､あるいは就職活動でお忙しいこととは存じますが、この研究が学士課程教育の向上を進める上で果たす社会的意義をご理解くださり、参加を検討して頂ければ幸いです。なお、この調査は、大学院に進学される方だけでなく、企業に就職される予定の方や公務員を目指されている方などを含め、全ての４年生女子を対象としております。

＊面接日時・場所＊
面接日時は、下記の日時を予定しています。

日程	６月	○日　○日、○日、○日	時間帯	１０時から１１時半
	７月	○日、○日、○日、○日		１２時から１時半
				２時から３時半
				４時から５時半のいずれか

できるだけ多くの方に参加して頂けるよう、皆さんの都合をお聞きした上で、私が面接日時を調整させて頂きます。上記の日程ではどうしても都合が悪いという方は､それ以外の日程に訪問させていただくことも可能ですのでお申し出下さい。所要時間は説明や休憩を含めて１時間半以内とします。面接場所は大学内あるいはその近辺とします。

＊面接内容＊
面接では、大学卒業後の進路を決められる経緯について、主として学士課程における経験を中心として、日本語で質問をさせて頂きます。差し支えない程度で結構ですので、できるだけ具体的にお答えください。頂いた回答に対し、さらに質問をさせて頂く場合もあります。

＊研究方法＊
面接内容はデジタル機器にて録音し、文書に起こします。録音を希望されない場合は、詳細なメモをとらせていただきます。その上で、面接を行った方全員の面

接内容を対象として、質的に分析させて頂きます。分析結果は、博士論文としてまとめます。希望があれば、参加してくださった方にも要旨を送らせて頂きます。

＊プライバシーの保護＊
面接調査を通してこの研究のために提供くださった情報に関しては、厳重に管理し、皆さんの名前や大学名がわかるような形では公表しない等、プライバシーを保護しますのでご安心ください。具体的な方法については、同意説明文書（参加希望者に後日配布し、説明します）をご覧ください。なお、この研究はミズーリ州立大学研究倫理委員会の許可を得て行われております。

面接調査に参加してもよいという場合は、1）お名前、2）大学及び学科名、3）連絡に使うためのメールアドレス、及び4）第3希望までの面接希望日及び時間帯を「6月20日10時」のようにお書きの上、○月○日までにメールにて下記までご連絡ください。私から後日、折り返し連絡させて頂きます。なお、残念ながら参加に対する報酬は出ませんので、予めご了承下さい。

連絡先
ミズーリ大学コロンビア校大学院
教育政策・リーダーシップ分析学科
博士課程　保坂雅子
<E-mail address>

Appendix C: Informed Consent Form (English)

Title of Project: Japanese Female Engineering Students' Postgraduate Decisions to Pursue Graduate Education: The Role of the Academic Department in Informing Their Fitness in the Field.
Student Investigator: Masako Hosaka
Faculty Advisor: Jennifer L. Hart

I. Purpose of the Study
The purpose of this study is to investigate how Japanese female engineering students in Japan decide their postgraduate plans through semi-structured qualitative interviews. Japanese female fourth-year engineering students in multiple national universities in Japan will be participating in this study. The participants are racial and ethnic Japanese. The final analysis will include a summary of common themes and ideas that represent the Japanese female engineering students' experiences of deciding their postgraduate decisions.

II. Procedures
The procedure involves one individual interview that is conducted at mutually convenient time to both participants and the researcher in 2009. The interview lasts for approximately 90 minutes, including the time that is needed for explaining a consent form. Interviews may be audio recorded and transcribed by the student investigator or a paid transcriber.

___ I agree to be audio recorded during my participation in this study.
___ I do not agree to be audio recorded during my participation in this study; however, I agree that the researcher takes notes.

___ I agree that my interview will be transcribed by a paid transcriber.
___ I do not agree that my interview will be transcribed by a paid transcriber; however, I agree that the researchers transcribe my interview.

III. Discomforts and Risks
Participants may feel uncomfortable being interviewed about their perceptions of their experiences of deciding and applying for graduate programs. There are no known risks associated with participating in this research project.

IV. Benefits
The research may not benefit participants directly. The benefit to society includes a better understanding of Japanese female engineering college students' experiences of deciding to pursue graduate education, which will contribute to the improvement in undergraduate education and higher education policy making.

V. Extent of Anonymity and Confidentiality
The information in the study records will be kept strictly confidential. Data will be stored securely in a file cabinet that is accessible only to the investigators. No reference will be

made in oral or written reports which could link the participants to the study. At no time will the researchers release the results of the study to anyone other than individuals working on the project without the participant's written consent.

VI. Compensation
Participants will not receive any monetary compensation.

VII. Contacts
If you have questions at any time about the study or the procedures, you may contact the student researcher, Masako Hosaka at: Educational Leadership and Policy Analysis, 202 Hill Hall, the University of Missouri-Columbia, mhwbd@mizzou.edu, or (573) 268-2844. She can also be reached at <E-mail address> while she is in Japan. You may also contact Masako Hosaka's faculty advisor, Dr. Jennifer L. Hart at: Educational Leadership and Policy Analysis, 202 Hill Hall, the University of Missouri-Columbia, hartjl@missouri.edu, or (573) 882-4225. If you have questions about your rights as a participant in the research project or wish to report a research-related injury, please contact Campus IRB at: 483 McReynolds Hall, the University of Missouri-Columbia, (573) 882-9585, or umcresearchirb@missouri.edu.

VIII. Voluntary Participation
Your participation in this research is completely voluntary. You may decline to participate without penalty. If you decide to participate, you may withdraw from the study at any time without any penalty and without loss of benefits to which you are otherwise entitled. Also, you do not have to answer any questions that may be asked.

IX. Subject's Permission
If you consent to participate in this study to the terms above, please print and sign your name and indicate the date below. You must be 18 years of age or older to consent to participate in this study. You will be given a copy of this form to keep for your records.

_____
Name of the Subject

_____ _____
Signature of the Subject Date

_____ _____
Signature of the Investigator Date

Appendix C: Informed Consent Form (Japanese)

研究に参加していただく女子大学院生の皆さんへ

同意説明文書

研究の名称：女子工学部生の卒業後の進路に関する意志決定
研究者名：保坂雅子
指導教官名：ジェニファー・ハート

＜趣旨＞
この同意説明文書は、あなたにこの研究の内容について説明させていただくことを目的とするものですので、よくお読みになり、研究にご参加いただけるかどうかご検討下さい。なお、この研究に参加するかどうかはあなたの自由であり、研究に参加すると表明した後でも、いつでも自由にやめることができます。この研究に参加するかどうかを決めていただくためには、あなたに研究の内容についてできるだけ多く知っていただくことが必要です。説明の中でわかりにくい言葉や疑問、質問がありましたらどんなことでも遠慮なくお尋ねください。

＜研究の目的について＞
この研究は, 日本の女子大学生がどのように卒業後の進路を決定しているのかを、国立大学工学部に在籍する４年生女子に対する面接調査により明らかにすることを目的としています。

＜研究への参加について＞
この研究に参加していただくための基準としては、日本人女性であること、現時点で２５歳以下であること、そして国立大学の工学部に在籍していることが必要です。この研究に参加していただく期間は，平成２１年６月から８月の間の１日です。

＜面接の内容について＞
面接は、あなたの都合のよい日時をお聞きした上で予め決めた日に、１度だけ行います。所要時間は、同意説明文書の説明及び休憩を含め、１時間半以内です。面接では、あなたが卒業後の進路を決定した過程について、主として学士課程における経験を中心として質問をさせて頂きます。その上で、あなたのお答えに対し、さらに質問をさせて頂きます。面接内容はデジタル機器にて録音し、研究者自身あるいは第三者が文書に起こした上で、質的に分析させて頂きます。面接中にメモをとることがあります。
____面接内容を録音すること及びメモをとることに同意する。
____面接内容を録音することには同意しないが、メモはとってもよい。

____　第三者による面接内容の録音起こしに同意する。

____　第三者による面接内容の録音起こしに同意しないが、研究者による録音起こしに同意する。

＜研究への参加の自由と同意撤回の自由について＞
この研究に参加するかどうかはあなたの自由です。また，研究に参加すると表明した後でも、いつで
も自由に同意を撤回することができます。

＜研究参加に伴う危険や被害について＞
特にこの研究への参加に伴う危険や被害はありません。ただし、質問内容によっては面接中に気分を害されることがあるかもしれません。ご了承ください。

＜研究の利益＞
研究に参加するあなたに直接の利益があるわけではありませんが、あなたの協力によって遂行されるこの研究によって、女子工学部生の卒業後の進路選択に関する理解が深まることは、日本の学士課程教育や高等教育の政策形成にとって利益があると考えられます。

＜プライバシーの保護について＞
面接調査を通してこの研究のために提供くださった情報に関しては、あなたのプライバシーを保護します。デジタル方式で録音された面接内容及び面接内容を記録した文書は、研究者あるいは指導教官の研究室もしくは自宅で厳密に管理されます。面接内容を録音起こしする段階で、第三者を雇用する場合がありますが、面接内容の守秘に文書により同意した者しか雇用しませんのでご安心ください。面接内容は、あなたから改めて同意を得ない限り、第三者にそのままの形で公表することはありません。分析後の面接内容について、博士論文及び学会発表、学術雑誌への発表という形で公表する場合は、あなたのお名前またはイニシャル、及び大学名がわかるような形では公表しませんので、あなたのプライバシーに関わる情報は守られます。

＜研究参加に関する相談窓口＞
研究参加について何かご質問があれば、面接の前後に関わらず、メール(mhwbd@mizzou.edu もしくは<E-mail Address>)にて保坂雅子までご連絡ください。アメリカでの連絡先は Educational Leadership and Policy Analysis, 202 Hill Hall, the University of Missouri-Columbia です。日本での連絡先は<電話番号>です。ミズーリ州立大学での指導教官ハート助教授 (Dr. Jennifer L. Hart) の連絡先は Educational Leadership and Policy Analysis, 202 Hill Hall, the University of Missouri-Columbia (メールの場合は hartjl@missouri.edu)です。もしあなたが研究参加者としての権利について質問したい場合、あるいは研究に関連する怪我などに関して報告したい場合は、ミズーリ州立大学の大学研究倫理委員会（Institutional Research Board）までご連絡願います。連絡先は 483 McReynolds Hall, the University of Missouri-Columbia(メールの場合は umcresearchirb@missouri.edu)です。

研究に参加して頂き、あなたとの面接内容を分析の対象として利用することを了承していただける場合は、下記にサインをお願いします。

_____
お名前

_____　　_____
サイン　　年　月　日

_____　　_____
研究者のサイン　　年　月　日

Appendix D: Interview Questions (English)

Q1 Describe yourself as an engineering student.

Q2 Tell me about the process of deciding your postgraduate plans.

Q3 Tell me about the people with whom you are acquainted with in the department. Please answer separately before and after you entered the research unit.

Q4 Tell me about your academic experiences in the classroom in your major department in the last 3 years.

Q5 Tell me about your academic experiences outside the classroom in your major department in the last 3 years.

Q6 Tell me about any experiences and events that informed you about your adaptability in engineering. Please consider "your adaptability in engineering" as the study itself, the particular department, and work in the field.

Q7 Tell me about any other options you considered in terms of your postgraduate plans.

Q8 Tell me about your experiences of discussing and/or consulting with someone about your immediate plan after you graduate from college and your future career during last year?

Q9 Tell me about your changes as an engineering student during college and future changes you expect as an engineering student and as an adult (who has a career).

Q10 How has gender influenced your collegiate experiences and postgraduate decisions?

Appendix D: Interview Questions (Japanese)

面接質問リスト

質問１：始めに自己紹介をかねて、工学部生としてのあなた自身について話してもらえますか。

質問２：あなたが現在の卒業後の進路を選ばれるに至った経緯を話してもらえますか。

質問３：学科の人たちの中で、あなたが知り合った人について話して下さい。

質問４：あなたの〇〇学科での３年間の授業での経験について話して下さい。

質問５：あなたの〇〇学科での３年間の授業以外での学業生活に関する経験について話して下さい。

質問６：〇〇学科の学生としての、適性について実感した、実感させられた経験や出来事があれば話して下さい。

質問７：卒業後の進路について、あなたが今計画している進路以外に考慮された他の選択肢があればそれについて話して下さい。

質問８：去年１年間、誰かとあなたの大学卒業後の進路及び将来の職業計画について話をしたこと、あるいは相談をしたことがあれば、その時の経験について話して下さい。

質問９：工学部（〇〇学科）の学生として、入学してから今までの間に、あなたはどのように変わったでしょうか。またこれから工学部（〇〇学科）の学生として、さらには社会人として、どのように変わるでしょうか。あなたが考えることを話して下さい。

質問１０：あなたが女性であるということが、あなたの大学生活あるいは卒業後の進路の選択に関してどのような影響を与えていると考えますか。

Appendix E: List of topics Participants Rated

For interview question 2
1. Degree of certainty of pursuing a master's degree
Point 1: Entry
Point 2: 1-2 year
Point 3: At the beginning of the third year
Point 4: Shukatsu period
Point 5: At the beginning of the fourth year
Point 6: Now

For interview question 3
1. Degree of interactions with people within the department till the end of the third year
2. Degree of interactions with people within the department after the beginning of the fourth year
Female classmates
Male classmates
Advanced students
Professors
Staff

For interview question 4
1. Degree of satisfaction with the classroom instructions
2. Degree of understanding of the classroom instructions

For interview question 5
1. Degree of studying
2. Degree of studying with friends (Frequency of studying with friends)
3. Degree of asking professors questions (Frequency of asking professors questions)

For interview question 8
1. Degree of contacts for postgraduate decision making (talked, asked, consulted, shared information, etc.)
Female classmates
Male classmates
Advanced students in the department
Professors in the department
Parents (mother, father)
Significant others
Others

Overall
Degree of satisfaction with the university

Appendix F: Original Quotations

Being Different within the Program

Page 94, Yoko (Degree, Central)
最初の頃はぎすぎすした感じですけどやっぱり。何というか男子の世界みたいなんだみたいな感じで。その中にも女子がいたって関係ないなみたいな感じで。[・・・]まあ、そうですね。距離を置いたっていうか。女子は女子みたいな感じで。

Page 96, Kazumi (Degree, Central)
女の人にはなんか、その人が、その生徒さんがやってないのかやってんのか分からないけど、怒ったところを見たことがないらしくて。
Q 今までに。
そうですね。だから男の人に対しての当たりは結構強いけど、女の人はそんなにみたいな。言えないこともあるのかもしれないですけど。なんかそんなのも聞いたりして。

Page 97, Misato (Work, Central)
あの、教授に「院に行こうかどうか迷ってるんです」って言った時も、男の先生だったんですけど、「ああそうだよね」っていう位で。それくらいなもんですかみたいな（笑い）感じだったんで。

Page 98, Erika (Degree, Central)
うーん。入った時から、まあでもそうですね。やっぱ人数、女の子少なかったので、周り、入った時から、周りが男の子ばっかりで、うーん。女の子しか友達がいなかったらちょっと寂しいし。人数少ないしっていうのもあって、自然となっていきましたね。

Constrained Engagement in Engineering Learning

Page 100, Kazumi (Degree, Central)
なんか、うーんどうなのかなって思ったのは、なんかひたすら式を羅列、黒板に書いて。特に質問は。説明するわけでもなく。なんか見直した時にノートを。何がしたいんだろうと思うような先生とかもいたりして。その先生はテスト大変でしたね。

Page 102, Tomoko (Work, Western)
一度授業を受けているのに、それについて聞きに行く。分かってないよって聞きに行ったりするので。そういうところで申し訳ないと感じたり、はしました。

Page 102, Hatsu (Degree, Western)
聞きに行ったら多分返してくれるんでしょうけど、なんかこんな質問していいのかなとかそういうのがあってなかなか行けなかったです。

Page 103, Yoshie (Degree, Western)
自然に集まってて、学校終わって、先ず、実験が終わった段階で、「ああ疲れた。お疲れ、お疲れ」って言った後に、帰る道の固まりが先ず、女の子と男の子で、少し分かれてながら。男の子で、「チョー俺、飯食って図書館に行くわ」。「あ、俺も行くわ」みたいな感じで行くんですけど。でも女の子は。
Q 別の所にいるから声がかからない。

かからない。たまにお前の力が必要だとかいう時は連絡くれたりするんですけど。

Page 104, Sayo (Degree, Central)
「これ洗っとこうか」みたいな感じで。実験器具洗って終わっちゃったりとか。やっぱり、どっちかっていうと、性格的に、誰もやらないと、やらなきゃって思う人。なんで。誰かやってくれると、「ああいいかな」ってそこをちょっと下がってしまうんで。そうやって、はい。

Page 105, Hatsu (Degree, Western)
人とおる時は。たまに人に頼ってしまうことがあるんですね 。人の力に頼って自分で解決しなかったこととかもやっぱあるんで。そう考えると、個人でやって、分からない時に聞いて、それでまた消化するって形の方が。あとやっぱレポートとか。班レポートだったら他の人が難しいことやったりとかいう ことが多かったし。みんなでプレゼンの時も難しいことは他人の人に任せるとかそういうことが多かったんで。

Page 106, Misato (Work, Central)
みんながしようしようという人だったんで。私もちょっと前から「ああ、せなな」っていう風に。私多分１人だったら夜中一夜づけなんで。

Page 107, Yoshie (Degree, Western)
１年まではこう、遊んでたりとか、何とかなるだろうみたいな感じがあったんですけど。本気で進学とか考えると、考え始めると、「この単位取らないと今年留年するよ」とか、いう話を友達として。これちょっと行かないといけないねって。１人じゃ行きづらいこともあって、大体友達と２人とかで。

Page 108, Megumi (Degree, Central)
復習とかするの嫌いなんで、まあ、なんか、授業中に、その時は割と、集中して聞いて、聞く方で。うーん。しゃべってる人とかいると割といらってしますね。（笑い）
Q じゃほんとにもう集中して。
まあ先生、授業する先生にもよりますけど。ほんとに、この授業意味ないだろうっていう感覚を受けたものはそんなにまじめっていうわけでもないですけど。まあ。まあ大体きちんと取って。

Page 109, Kei (Degree, Western)
ある程度どこが分からないのかを自分でも説明出来るように、分からないところあるけど、大体こう理解して、こうこうこう考えたんですけどここが分からないんですみたいな。そうしないと私も、逆に全く分かんない状態で行って聞いても分からないと思うんですよ。

Page 110, Kaori (Degree, Western)
会話しやすい雰囲気を作るじゃないですけど、もう、片っ端から声を誰にでもかけて、みたいな、のは女の役割なのかなというのを感じました。
Q 役割ですか。
はい。男の競争の中に属さないからできることなのかなと思って。

Page 112, Natsu (Work, Central)
大学だと、なんか、うーん。「聞かない人はもう知らないよ」みたいな感じ。っていうとちょっと言葉が悪くなるんですけど。なんか。うーん。
Q 聞かないというのは授業ですか。
はい。授業の話ですね。なんか理解してもらおうと思って先生がしゃべってるんじゃないような気がしたんですよ。。。

Page 112, Kumi (Work, Central)
なんか、よかったのは。こう、、、かみ砕いて教えてくれるって言うか、分かりやすく、、、順を追って説明してくれたら、「ああ、なるほどな」って分かるけど、なんか、あんまり分からなかったら、なんて言うんですかね、「もうこうなるからこうなんだよ」みたいな、「分かるでしょ」みたいな感じの先生もいたから。
Q それは説明無しで。
説明無しで、もう「今までこれやってきとうんやから、ここ分かるでしょ」みたいな。

Page 113, Tomoko (Work, Western)
勉強、期末前とか、勉強あまりしないで、頭で理解してるから問題が解けるっていう人たちと、私みたいにほんとに何時間も勉強して、ずっと努力を重ねた上での結果っていう、その、本質、なんでしょうね。天才肌と、その努力派、っていうのは感じましたけど。

Page 113, Mei (Work, Western)
実験とかのプログラムを作ったりすると、やっぱり、なんか、気合いの入れ方っていうか、なんていうんだろう、なんか、私はここまで頑張れないなっていうのは、感じることはあります。頑張ってもここまでできないなっていう。同じだけやっても多分できないなと思うんで。
Q: じゃそれは人のそういう仕事を見て思うってことですか。
そうですね。できる人は、自分よりできる人は一杯いるなっていうのは実験とかでは感じましたね。

Page 115, Jun (Work, Central)
あのよく、私が失敗するんで、「なんか悪いな」、とか思って。
相手の人は「いいよ。いいよ。」って言ってくれるんですけど。
なんで、多分どんどん苦手、嫌いに。

Page 116, Kei (Degree, Western)
専門性が増すと難しくなってくるし。なってきた時になんか、「ああ、ここまでやりたいのかな」みたいな、思った時はありました。「ほんとに＜専門分野名＞やりたいのかな」みたいな。でも、3 年なって実験が増えてきたし、で、レポートとかは結構自分で考察したりとかするし。そういうのは別に嫌いではなかったんですよね。実際実験やって、なんでこうなるんだろうか、考えたりとかするのは。うん、ずっと勉強してるよりも、なんか逆に、そうやって実験したりした方が興味がわくんですよね。なんでこうなるんだろうって。そうなったら、なんか、参考書とかに書いてある難しいことも、理解しようとするんですよね。

Page 117, OK12 (Degree, Central)
これが答えになってるけど、何でこうなっとる、何でこれじゃないんかなっていうのを考えるんですけど。友達に言っても。「え、すごいな。何でそんなこと思いつくん。」っていうそんな返ししかない子達で。[・・・]「答えどうなる」んって。「あ、ありがとう」みたいなかんじ。あんまり一方的な感じで議論みたいな感じではなかった。

Page 117, Yayoi (Degree, Western)
その、あんまり、こう、実験が上手くない人もいるから。その人をどう使うかというか（笑い）、どういうポジションに持ってくるかみたいな。考えて。２，３人でいつもやってたんですけど。その時とかも、、、うーん。なんかその、少人数のグループになると、大体、その、「何やって、あれやって、これやって」みたいなことは言ってました 。

Postgraduate Decision Making

Page 121, Yori (Work, Central)
５分待ちだとか、１時間待ちだとか。そういうのをなんか、自分の中では。窮屈に感じたりだとか。実験する上で窮屈に感じるところがあって、でそれで、なんか、自分には実験あってないのかなって思ったんです。[・・・] えー。なんか後は、やっぱ、その、すごい、時間がかかる。時間を制限される感じ。いつ終わるか分からないみたいな。その、なんか、縛られてる、実験に縛られてるみたいな。なんかそういう感じも自分の中ではいやだったような気がします。

Page 122, Moe (Work, Western)
あ、研究職って言うのもあるんだっていうのをやっぱり知って。あ、研究が好きな人はすごく楽しいだろうなって、ちょっと客観的じゃないですけどそういう風に思いました。
Q じゃそういう仕事があってそういう仕事に就けるっていうことは聞いたけれども、自分のこととしてはあまり、思わなかった。
あんまり現実的に自分がやるかっていうのを考えなかったです。はい。

Page 124, Mei (Work, Western)
なんか、「院に行ったら遊べるよ」って言われるんですよ、先輩から。だから、遊べるよって別に遊ぶために院に行くならそんなに高い学費払って勉強とかもすると思うけど、だったらなんか、就職して自立した方がいいんじゃないかなと思います。・・・甘えてる感じ。その、なん、そのやっぱ、「学費払って行ってるのに、何しに行ってるんだよ」ってなりそうで。中途半端になりそうな感じがいやだったんで。

Page 127, Kazumi (Degree, Central)
研究室がどんなところなのかっていうのがよく分からなかったので。だからもう＜専門分野名＞はいい。授業、を受けてきての印象は。もう＜専門分野名＞はいいやっていうようなことで。
Q それはこれ以上やらなくてもいいっていう
そうですね。もう。テスト。授業受けてテスト受けてっていうのが。多分いやになってたんでしょうね。でもなんか。研究は、だから、、、自分がこうしたければ、こうなんか方向転換というか、分からないことを後どんどん研究していくので、なんかそういうおもしろさっていうのは３年までは、分からなかったですよね。

Page 128, Kei (Degree, Western)
こういう先輩、なんか、なんて言うんですか、学会とか、そういう、そんな活動とかしてる先輩がいるとか、ここの研究室は、なんかこう、活動っていうか、いろいろ国際交流が盛んだとか、そういう、もっと詳しい内容を、今度、まあ、ある人がイギリス行くって言ってたよとか、聞いたりとかしてたんで。それが、そしたら院まで行ったら、もっと大学生のうちにしかできないことを、しかも研究でとか、出来るからそれをもし自分ができるなら、チャンスがあるなら、まあ、就職してしまうより、何もやりたいこともまだわかんない、就職してしまうより、もっと、もっと、もうちょっと経験をいろいろしてみて、た、方がいいのかなって。

VITA

Masako Hosaka was born in Kitakyushu, Fukuoka prefecture in Japan as a first child of Yukihiko and Emiko Mori. She grew up with her brother, Hiroshi, and her parents in Fukuoka prefecture. They moved frequently because of her father's work as a public servant. She received her Bachelor of Art in Literature with an emphasis on East Asian History from Kyushu University and her Master of Art in Higher Education from Hiroshima University. Before beginning her master's degree program, Masako worked as a librarian at Nagasaki University and Yamaguchi University. While working on her Ph.D., Masako was a Graduate Assistant at Educational Leadership and Policy Analysis. She later coordinated a university's efforts to support women on campus at two national universities in Japan. She is married to Toshio Hosaka and currently lives in Tokyo, Japan.