

FACTORS OF WOMEN ENGINEERING STUDENTS' DROPOUTS IN SOUTH KOREA

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Abstract: In this study we conducted a factor analysis on the patterns and reasons of women engineering students' dropout phenomena through interviews and questionnaires carried out on the women students majoring in engineering at P University. The analytical results of the questionnaires indicate that a broad socio-cultural factor, the industry's negative gender cognition and the male-dominant atmosphere of the college of engineering are the three major factors that influence the women engineering students' decisions to drop out. In addition, the women engineering students' physical strength and machine-tool maneuvering ability that are by and large inferior to male engineering students, have greater influence than their academic competence or age. Parents' moral support also plays an influential role. Another important factor is the lack of gender cognitive lectures and gender cognitive job hunting projects for women students. It is recommended that the findings of this study be considered as basic materials in developing a gender cognitive engineering curriculum for women students that befits the environment of the college of engineering.

Keywords: Women Students, Dropout, Engineering Education

I. Introduction

Recently, Korea has been emphasizing creative economy, and one of the emerging important tasks is promoting and supporting female human resources in the workforce and job market as a means of realizing the goal of creative economy. In addition to the barriers that hinder women's advancement to high positions and interrupt their work careers, the measures of fostering and supporting women in science and engineering have become a big issue. However, women students are still facing a glass wall of male-dominant culture and curricula, the male favoring environment, and women's mental and physical differences from men in the college of engineering. As a result, many women students fail to break through the glass wall and end up in taking a leave of absence, or changing their majors from engineering and science to some other fields, or dropping out from the college of engineering completely.

Development of female human resources is an important task not only for the next generation growth power resources but also for enhancing the quality of women's lives. The OECD Mid-to-Long Term Economic Outlook Report (2010. 05. 31) had predicted that the potential growth rate of Korean economy for 2010-2011 would reach 4.0%, which is the highest among the 30 member nations observed; however, they also predicted that the growth rate of Korean economy would rapidly fall as low as 2.4% per annum by 2025. Moreover, they predicted that the new trend of avoiding engineering fields would bring about shortage of manpower in R&D and production lines, which would result in a setback in basic research in science and engineering, ultimately weakening the technological capability of Korea. To resolve these problems, the Korean government enacted a law of Fostering and Supporting Women Scientists and Engineers, establishing various government supporting policies (H. Y. Park, 2008: 151). Despite these government support policies, female students continue to experience much more difficulty than male students in the science and engineering fields. Differences between male and female students are not just physiological. Women students are being discriminated against not only at the university but, directly or indirectly, they are all experiencing prejudice and condescending attitude at home

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and society at all the sociocultural levels. These experiences can strongly influence women students individually.

Therefore, it is necessary to examine how women students' experiences differ from those of male students and why more women students drop out of college. To find out the factors that contribute to the decision to drop out, we conducted interviews and a questionnaire survey. The survey questions were made on the basis of the thoughts and remembrances which women students have had in their campus life about dropping out of school.

After the factors contributing to women students' dropout were defined and the content validity was verified by the experts, the women students majoring in engineering were surveyed. The subject of the survey is P University whose women students majoring in engineering constitute 23% of the student body of the college of engineering as of 2014, which is the nation's highest women student ratio. The purpose of this study is to apply the analytical result of the survey of the factors contributing to women student dropouts in developing a women students engineering education program that befits the engineering college.

II. Theoretical Background

1. Definition of Dropout

In general, dropping out refers to the act of discontinuing the coursework of regular school or college. Morrow (1986) classified dropouts into five types: (1) the push-outs who got pushed out of school after being judged as disqualified students; (2) the unaffiliated students who refuse to associate with others; (3) the capable dropouts who quit school despite their capability because the school and the family demand different values from the students; (4) the educational mortalities who are incapable of completing the coursework, and (5) the stop-outs who return to school. In other words, dropouts are those who stop going to school for various reasons either of their own will or against their will.

For quantitative analysis of the factors contributing to women students' dropout decisions in this study, the measurement standard is the women students who initially enrolled in engineering departments but dropped out to transfer to some other fields. Although the women engineering students on leave of absence can also be a dropout factor that contributes to changes in the major field, they are excluded in this study for they will be the subject of our next research project. The academically outstanding women engineering students' transfer to other major fields is a big loss in engineering human resources since they are highly demanded in the industry, and thus it is a dropout type that has an important significance.

2. Factors of Women Engineering Students Dropouts

Dropout phenomenon is attributed not just to one factor but to the combined effects of multiple factors (Y. S. Cho, 2010: 10). Boshier (1973) wrote that chances of dropping out increase when the internal harmony with one's self does not match the harmony of the self with the environment. Garrison's (1987) more macroscopic analysis offered nine factors of dropout: the idealistic self, the self-trust, adequacy of the process, the level of achievement, support for individual students, control by the educational institution, mismatch of the ego with the super-ego, clarity of the objectives, and finally the academic competence. Table 1 gives a thematic summary of researches on dropout phenomena.

Table 1. A thematic summary of researches on dropout phenomena

Factors	Detailed Content
Personal Factor	Concept of self / Self trust
	Classwork performance capability
	Academic ability
	Affiliation with Classmates and faculty members
	Single or married
	Age
Domestic Factor	Housework situation
Sociocultural Factor	Position, Regional background
University Factor	Major field
	How well does the content of education agree with the learner's goal
	Difficulty of coursework
	Satisfaction level of the educational environment
	Satisfaction level of the coursework

Source: Bae Kyung Suk, 2004: 21 Reorganized

Based on the research results reviewed above, the dropout factors are classified into four categories. (1) In the personal factor, variables are personal inclinations and high schools graduated from. (2) In the domestic factor, household conditions are the main variables. (3) In the sociocultural factor, the economic power of the region and the society are important variables. (4) In the university factor, match or mismatch with the majoring field and the environment are the main variables. (H. M. Park, 2009: 26-35). Research on dropout factors can also be conducted by focusing on differences between continuation and discontinuation of coursework of a college or a majoring field. (Y. J. Oh, 2006) However, the research target of this study is the women engineering students at a coeducational college of engineering. Women engineering students in different majoring fields will be the subject of future research.

III. Research Method

1. Research Procedures

For a factor analysis of women dropouts from an engineering college, we conducted a literature survey, in-depth interviews and a questionnaire survey. A quantitative measurement tool was developed on the basis of the factors reflecting the characteristic features of women engineering students' drop-out phenomena, which are extracted from the interviews. The validity and reliability of the measurement tool were confirmed by applying SPSS 18.

2. Research Target

A. In-depth Interview

In this study we interviewed 20 women engineering students who are attending P University. The in-depth interview refers to a kind of non-structured face-to-face interview that is capable of accurately drawing out the feelings and thoughts of the interviewees (Boyce & Neale, 2006). The P University is selected as the best engineering college to study women dropout problems since it has a relatively large

number of women engineering students in terms of gender ratio. Interviews, which lasted about an hour, were conducted from November 1, 2013 to December 10, 2013 at the P University campus where interviewees felt comfortable. The interviews were recorded with the permission of the interviewees. The questionnaire was written on the basis of the information obtained from the interviews.

B. Questionnaire

The questionnaire survey was conducted on 276 women engineering students. The measurement tool was extracted from the interviews of women engineering students, and its validity was confirmed by three professors of engineering, one Ph.D. in education, two graduate students majoring in education.

The questionnaire consisting of a total of 56 questions was written, including the personal factor (14 items), the familial factor (5 items), the University factor (14 items), the socio-cultural factor (18 items) and the basic questions (5 items). See Table 2. To prevent the tendency of respondents to check the middle point, a 5 point scale was designed (Very much, Somewhat, So and so, Not very, Absolutely no.)

Table 2. Frame of questionnaire for the four factors

Items	Personal Factors
1	Intention to transfer to other major or drop out of college as of now
2	Intention to drop out due to the influence of students around you
3	Your response to students who transferred to other major or who dropped out
4	Does your major agree with your aptitude and your interests
5	Relation between the degree of agreement with your major and dropping out
6	Anxiety about getting a job
7	Difficulty level of coursework in the majoring field
8	Timing of selecting the major
9	Available information about engineering college at the time of selecting the major
10	Dissatisfaction about the curriculum of the major
11	Availability of consultants (mentors) to discuss your troubles about the major and future career
12	Possibility of landing a job in the field you are majoring in.
13	Inner conflict about your major
14	The main agent that decides your career and your satisfaction
Items	Domestic Factors
15	Parents' perception of women engineering students
16	Financial conditions of your family
17	Part time work and payment of your school expenses
18	Problems encountered when your school work and part time work are simultaneously carried out
19	Parents' occupations

Items	Sociocultural factors
1	Society's prejudice against women engineering students.
2	Gender differences in the job hunting competition
3	Business owners' perception of women workers
4	Gender differences experienced during one's career as a worker
5	Businesses' preference for men or women
6	Comparison of engineering fields with liberal arts fields in terms of job landing and success
7	Gender differences in terms of culture
8	Role model in the engineering fields
9	Job landing for men and women in terms of culture
10	Average number of years the job is held by men and women after getting the job (marriage, child birth, etc.)
11	Male-dominant culture in businesses
12	Gender differences in preparations for job hunting
13	Does the female culture agree with business culture
14	Culture of workplace and barriers
15	Gender differences for the environment of career jobs
16	Unconscious sex discrimination due to culture differences
Items	College Education Factor
1	Distance between the college and your residence
2	Gender cognitive teaching methods
3	Gender cognition in the coursework of the majoring field
4	Ratio of female professors in engineering college
5	Atmosphere of engineering college for a particular gender
6	Gender differences in Lab classes
7	Leaders in the team projects and classroom work
8	Level of gender cognitive lectures
9	Supplementary training for women students
10	Courses directly related to employment of women
11	Effects of supporting and fostering projects for education of women
12	University's special attention for women engineering students

3. Data Processing and Analysis

A. In-depth interviews

The recorded interviews were transcribed as soon as possible, and while reading over the transcribed content, the phrases and sentences related to dropout factors were jotted down. Comparing notes on these phrases and sentences, the participating researchers derived the tentative dropout factors that had a high degree of agreement. The data containing the factors thus derived were analyzed, and they were compared with the factors that had been derived earlier, and they were revised and combined. Through repeated feedback, conceptualization of data, and categorization, the factors of women engineering students' dropout phenomena were finally defined.

B. Questionnaire Survey

We conducted a descriptive statistical analysis, a reliability analysis, and a validity analysis on the data collected through the questionnaire survey. First, in the descriptive statistical analysis, we sorted out the questions whose standard deviations are below .10, the questions whose skewness and kurtosis are above ± 2.0 , and the questions with weak discrimination capacity whose response rate is biased more than 50%. Second, in the reliability analysis, we used Cronbach's α coefficient which is capable of evaluating the internal consistency of the items. Cronbach's α values are useful in identifying and eliminating the items that hinder the reliability. If the α value increases when a variable is removed, removal of that variable enhances the reliability of the item. In other words, at the early research stage, the α value of 0.5~0.6 is considered as relatively good and the α value of above 0.7 is good enough to be accepted (Nunnally, C., 1976). According to Y. J. Lee(1991), the α value of above 0.7 is good in general. Third, the factor analysis is a method of identifying the components that make up the items which are found by the reliability analysis to be appropriate. In this study, we conducted a factor analysis for each of the four factors. Specifically, our four factors were determined by conducting a principal component analysis. Varimax of the right angle rotation method is used for the rotation method. The number of factors was determined by using the scree test, eigen value, gross dispersion rate of more than 60%, and interpretation potentials. Finally, the validity of the factors was confirmed through the eigen value, the common dispersion versus gross dispersion rate, and the interpretation of the content.

IV. Research Results

1. Extraction of Dropout Factors through In-depth Interviews

The analytical results of the in-depth interviews revealed four major differences from the previous research on dropout factors.

First, the previously defined social factors were found in this study to include more comprehensive ranges of socio-cultural factors because women engineering students gave significant responses to cultural factors such as the culture of male students attending the college of engineering and its difference from that of women engineering students. In addition, the negative cognition about women engineering students perceived in business and industry and the male-dominant atmosphere of the engineering college were the sub-factors found in their responses instead of the conventional research sub-factors of position and regionalism. Many interviewees opined that although the male-preferring attitude of society is said to have improved much, it is still there and annoying to them.

Second, the personal physical strength and personal ability to maneuver machine-tools, which aid their academic performance, are added to the conventional research sub-factors of academic performance and age. The most dominant opinion in the interview content is that women engineering students felt they are limited in their physical strength when participating in the engineering lab work and lab assignments. This reveals the physical difficulty experienced by women students in carrying out their study in the majoring fields is greater than that of male students.

Third, along with the conventional research sub-factor of household situation, parents' support was derived as a new sub-factor. This indicates that parents' support gives strong motivation to women engineering students. Fourth, for the factors related to college education, sub-factors that are more specific than the conventional research sub-factors were derived, such as gender cognitive lectures and instructions and university's support for job hunting. Many interviewees commented on the need to eradicate sexism from lectures and classroom work and the need of University' support for various minority students. These comments indicate that women engineering students are influenced greatly by how the university plays its roles.

2. Analysis of Dropout Factors Through Questionnaire Survey

A. Descriptive Statistical Analysis

Examination of the standard deviation, skewness and kurtosis of the four major factors yielded the following data: The averages of the personal factor, the family factor, the university education factor, and the socio-cultural factor are 2.21~3.61, 2.52~3.25, 2.12~2.93, 2.72~3.31, respectively, and the answers are by and large evenly distributed. The standard deviations for the questions for the four factors are distributed between 0.89~1.35, 0.92~1.21, 0.85~1.14, 0.98~1.41, respectively, which indicates that the answers for all the questions given by the interviewees are properly distributed. The skewness is distributed between -1.31~0.38 and the kurtosis between -0.68~1.78 on the average, which also shows that the answers given by the respondents to all the questions are not biased but evenly distributed.

B. Reliability Test

The test score of the reliability of the dropout factors of the women engineering students in this study ranged between .620 and .857. This is a relatively high score for the results of social science research. See Table 3.

Table 3. Reliability analysis

Factors	Cronbach' α
Personal Factor	.857
Domestic Factor	.620
University Education Factor	.633
Sociocultural Factor	.816

C. Factor Analysis

A factor analysis was conducted to measure the variable factors accurately by using the principal components analysis and the vari-max of the right angle rotation. In this study, the results of interviews were classified into the personal factor, the domestic factor, the University-education factor, and the socio-cultural factor, and the factor analysis was conducted on these four factors. Since the extracted samples explain the population clearly, similar questions were classified as belonging to the same factor. As shown in Table 4, for the personal factor, an item is classified into new factors (sub-factors?) depending the nature of the question.

Factor 1 was named "dissatisfaction about selection of the major" because Item 9 (information on college of engineering at the time of selecting the major) and Item 8 (time to select the major) showed the highest score, respectively. Factor 2 is entitled "influence of the surrounding situations". Item 3 (response about students who transferred to other fields and about students who took a leave of absence) showed a value of .805. Factor 3 is named "networking with classmates and professors" because it is a factor that belongs to the same item that

deals with consulting on the anxiety about the major field and employment. Factor 4 is named “anxiety about employment”. We also calculated the percentage variance and eigen value for each factor. Variance is a value which informs whether each item is included in the relevant factor. Percentage variance is the ratio each factor possesses out of the whole 100%. The Eigen value informs whether the number of factors is appropriate, and the value is effective if it is greater than 1. Using the same method, the domestic factor is composed of 5 items. Factor 1 refers to “financial conditions” and Factor 2 is named “parents’ support”.

Table 4. Analysis of Individual Factors .

	Factor 1	Factor 2	Factor 3	Factor 4
Item 9	.856	.121	-.054	.113
Item 8	.837	.246	-.049	-.047
Item 10	.695	.168	.278	.276
Item 13	.474	.205	.298	.471
Item 7	.420	.381	.056	-.169
Item 3	.092	.805	.103	.384
Item 1	.148	.774	.318	.159
Item 2	.165	.708	-.109	.071
Item 5	.463	.632	.349	-.106
Item 11	-.150	.106	.791	.109
Item 14	.492	.002	.577	.235
Item 4	.520	.302	.553	-.220
Item 6	-.103	.141	-.069	.818
Item 12	.288	.086	.398	.658
Eigen Value	3.218	2.570	1.847	1.749
Percentage Variance	22.985	18.354	13.194	12.491

Table 5. Analysis of Domestic Factors

	Factor 1	Factor 2
Item 18	.884	-.145
Item 17	.847	-.027
Item 16	.762	.186
Item 19	-.159	.871
Item 15	.469	.528
Eigen Value	2.325	1.095
Percentage Variance	46.491	21.892

Table 6. Analysis of Sociocultural Factors

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Item 2	.764	.148	.069	.038	-.012
Item 3	.761	.053	.135	.246	-.174
Item 1	.700	.126	-.126	.154	-.252
Item 5	.689	.173	.115	.096	.191

Item 11	.653	.131	.164	.098	.323
Item 14	.138	.748	.017	-.021	.214
Item 15	.238	.711	.025	.122	.070
Item 16	.070	.683	.096	.330	-.076
Item 13	.016	.554	.518	-.136	-.211
Item 9	.013	.103	.801	.200	-.048
Item 4	.467	-.162	.560	-.001	.150
Item 6	.136	.046	.035	.803	.047
Item 7	.239	.250	.318	.470	.139
Item 12	.165	.306	.413	.414	-.076
Item 8	-.075	.032	-.111	.115	.829
Item 10	.502	.243	.187	-.182	.511
Eigen Value	3.212	2.181	1.633	1.370	1.337
Percentage Variance	20.074	13.629	10.206	8.563	8.354

Table 7. Analysis of University Factors

	Factor 1	Factor 2	Factor 3
Item 2	.704	-.049	.057
Item 4	.676	.090	.068
Item 5	.623	.037	.100
Item 6	.585	.436	.037
Item 3	.529	-.103	.437
Item 12	-.184	.674	.269
Item 9	-.002	.649	-.038
Item 10	.373	.591	-.393
Item 8	.166	.508	.016
Item 1	.256	-.188	.587
Item 7	.167	.167	.569
Item 11	-.289	.422	.518
Eigen Value	2.341	1.936	1.375
Percentage Variance	19.508	16.130	11.460

The socio-cultural factor in Table 6 combines the two separate factors (social and cultural factors) into one factor. The socio-cultural factor is divided into five factors. Factor 1 is named “the negative perception held by businesses about women engineering students” because Item 2 (gender difference in competition for employment) and Item 3 (Business owners’ perception of women) played the role of the biggest factor. Factor 2 was named “Discrimination against women employees”, and the items about workplace culture and the barrier factors showed a high value of .748. Factor 3 was named “Getting a job and life at workplace”; Factor 4 was named “Preparation for employment and gender differences”; Factor 5 was named “Absence of Role Model”. Item 8 is a question about the role model in engineering fields, and the responses to Item 8 indicated that the women engineering students strongly feel the absence of role models and they demand improvement.

As shown in Table 7, University Education Factor is classified into three categories. Factor 1 is involved with Item 2 through Item 6, and it is named “The atmosphere of engineering college and male professors’ absolute majority”. Factor 1 is composed of Items on gender cognitive teaching method and gender cognition in major

engineering fields. Factor 2 is composed of Items on the University's special considerations for women students and supplementary training for women students, and it is named "Lack of gender cognitive lectures". Factor 3 is named "Lack of University support for Women Engineering Students", and here the sociological question of prejudice against women engineering students showed the highest value of .587.

V. Conclusions

Our findings from the in-depth interviews and the questionnaire survey conducted on P University women engineering students led us to make the following conclusions on the patterns and causes of women engineering students' dropout phenomena. We developed a measurement tool capable of grasping the reasons why women engineering students are dropping out, and the questionnaire survey based on this tool enabled us to discover significant factors that produce women student dropouts. First, the most important factor that causes women engineering students to drop out is the lack of information and absence of mentors at the time they decide their majoring field as well as the reactions they saw the other women engineering students make as they transfer to other majoring fields. Second, the sociocultural factor, much broader in scope than the social factor, is at work as an influencing factor. The negative perception against women engineering students and the male-dominant atmosphere are felt in the businesses and industries. This is a factor more influential than the influence of position or regionalism. More than in any other fields, the women engineering students are aware of the influence of a role model, especially examples of women who succeeded in engineering fields. Third, women engineering students' physical strength and machine-tool maneuvering ability, which are inferior to those of male students, are also an influencing factor. Fourth, we also learned that the domestic factor of household chores and parents' support plays an important role. Fifth, the analysis of the University Education Factor informs us that gender cognitive education and the institutional consideration for the minority students are important. In other words, women engineering students' dropout phenomena are greatly influenced by the university's policies as in gender cognitive education and support in their employment after graduation.

It is expected that the results of this factor analysis may be used for basic materials in developing a women engineering student education program. Developing an engineering education methodology that reduces the dropout rate of women engineering students is an important issue not only for the next generation growth power but also for upgrading the quality of women's lives. Therefore, it is urgently needed to accurately grasp the women engineering students' dropout factors and develop a women engineering education program that is suitable for the environment of the college of engineering.

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