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# A Study on Analysis of Satisfaction for Engineering Convergence Subject

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***Abstract*— Our world is quickly moving towards the fourth industrial revolution including mobile, big data, AI, IoT, cloud computing, VR, etc. Recently, South Korea has been emphasizing convergence education to university. Thus, university has begun doing convergence education on their own by linking major subjects and liberal arts courses or linking different departments. In this paper, we analyzed learners' satisfaction for operating convergence education effectively to increase education satisfaction and developed convergence curriculum and convergence skills required by society. for this study, a satisfaction survey is conducted for students majoring in engineering colleges. And the students' experiences are collected through interviews and questionnaires for suggesting improved the convergence curriculum operation. We also did interviews and asked students about the meaning convergence education had for them, the impressions they had after taking the classes, and any opinions for further improvements. As a result of the analysis of student's satisfaction and satisfaction of convergence curriculum, it was analyzed as "approximately satisfied" with 3.6. Additionally, the correlation between student satisfaction and convergence curriculum satisfaction was analyzed, and the correlation coefficient showed a significant correlation with 0.732. In other words, it can be seen that students with high-student satisfaction are also highly satisfied with the convergence curriculum. Based on the result of the research and the student's opinions, we would like to suggest that there should be subject development that is connected to careers or job searching for senior students, and additional research of practical educational methods are also needed.**

***Keywords*— Convergence education; education effectiveness; satisfaction survey; engineering college; curriculum.**

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## I. INTRODUCTION

We are living in the fourth industrial revolution era where Information and Communication Technology (ICT), including mobile, big data, Artificial Intelligence (AI), Internet of Things (IoT), cloud computing, Virtual Reality (VR), etc., are converging and revealing a revolutionary transition in our economy, society, and culture[1],[2].

Convergence education aims to foster talented students who have problem solving ability and create imaginative values based on knowledge from various fields including math, art, engineering, technology, and science[3],[4]. In the case of the United States, STEM (Science, Technology, Engineering, Mathematics) education has been executed for over 10 years[5]. And this execution involves ideas that science, technology, engineering, and math are necessary for cutting-edge technology, and with this education, students can develop critical thinking, cooperation, and problem-solving ability that we need in our daily life. Recently they are trying an ARTBOTICS project by combining art into STEM education[6],[7].

In the case of South Korea, the 2015 curriculum revision introduced a new convergence education, THAIMS (Technology, Humanities, Art, Information, Mathematics, Science) which has been executed with middle and high school students. The basis of South Korea's convergence education is from the Yakman Pyramid model which sorts integrated, holistic education into different levels. From top to bottom the Yakman Pyramid model consists of the Life-long Level, the Integrative Level, the Multidisciplinary Level that contains STEM and art, and the Discipline Specific Level that consists of science, technology engineering, math, and art. Based on this model, the Korean education system aims to foster talented students who can solve future problems

creatively by encouraging curiosity and understanding of science and math, developing integrated thinking ability[8][9].

Recently, the Ministry of Education in South Korea has been emphasizing convergence education to university. Thus, university has begun doing convergence education on their own by linking major subjects and liberal arts courses or linking different departments. Those universities are executing converged talented students by emphasizing creativity, and are strengthening major education based creative convergence education systems to foster talented students who have creativity, expertise, connectivity, and durability.

In accordance with the Ministry of Education's policy, Universities in South Korea institutionally arranged programs to let students complete various programs of study such as interdisciplinary majors, self-directed learning majors, or combined majors. For example, B university is strengthening multi majors, minors, changing majors, interdisciplinary majors, and combined majors. Especially for interdisciplinary and combined majors, students can complete interdisciplinary and combined majors plurally (2-3 majors) to strengthen interdisciplinary education and fulfill students' desire to learn newly rising academic fields.

A self-directed learning major is a newly executed program where students can complete their credits on their own by opening new classes when they need to. These newly opened classes can be recognized as major subjects after being evaluated. So the concept of a self-directed learning major does fit the goals of convergence education[10].

When you look at the curriculum flowchart for convergence subjects in a college of engineering, freshman students learn basic knowledge by focusing on math, computer engineering, and science. As their years of studying progress, they learn their major field's technology, engineering, etc. For subjects such as art, society, politics, etc., they can learn as liberal arts subjects or general elective subjects[11].

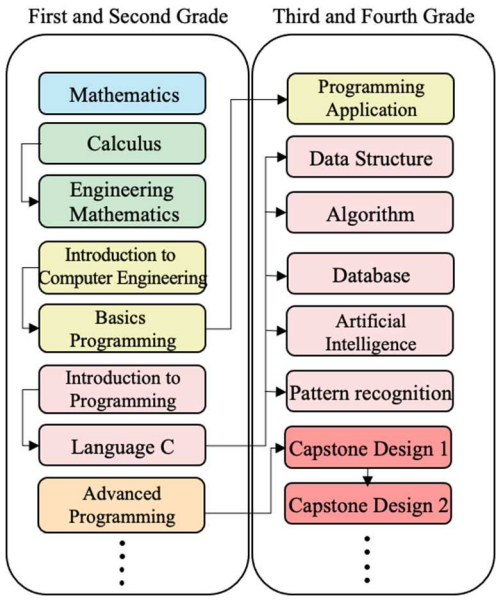


Fig. 1 A part of curriculum flowchart

The form of convergence education differs in each major, but these majors also have common standards because of commonalities within a college of engineering which involves teaching methodology to solve a problem and evaluating students by observing how they can solve a problem creatively.

To increase students' class satisfaction levels and to raise the convergence capability that society requests these days, this study analyzed learners' satisfaction levels in regard to convergence education and researched a curriculum improvement plan. Therefore, we suggest a subject and curriculum management improvement plan by executing surveys to students who are in the college of engineering, interviewing student's experiential opinions and analyzing them.

## II. Material and Method

Foremost, this survey aims to analyze students' attitudes towards normal major subjects and convergence subjects. We expected that students who have positive attitudes towards normal major subjects will have positive attitudes towards convergence subjects too. We expected the attitudes towards subjects would be more positive for juniors and seniors, who have more knowledge about major subjects and can utilize their knowledge in various ways, in comparison to freshmen and sophomores, who have just started to study their majors.

Also, we expect that male students, who tend to be relatively less risk averse, will show more preference for convergence subjects than female students. The representative convergence subject in a college of engineering is the capstone class. In a capstone class, students are led to converge their knowledge through cooperation. The aim of the capstone class is to train the convergence of collective intelligence, but it's not a simple task for students because the class has relative evaluation.

### *A. Content and Purpose of Survey*

To investigate the practical operation of the convergence subjects and the students' satisfaction levels, we executed a survey as follows. The content of the survey consisted of questions that asked about satisfaction regarding the subjects that they are currently taking and satisfaction in regard to convergence subjects. We also included interview questions that asked about curriculum management plans.

Because students might misunderstand the meaning of convergence subjects with their prior knowledge, we informed them of the meaning of convergence subjects at the top of the survey paper. After the survey, we asked students what they think the meaning of convergence subjects is, as well as their personal opinions after taking convergence subjects, and recommended improvements.

Before executing this survey, professors discussed which subjects were convergent in their opinion and we executed the survey to each grade and class based on these subjects. Also, we started to execute the survey right at the end of the semester when we could ask for class satisfaction and see the result of the convergence education.

To verify clearly, we divided the survey questions based on sections, and analyzed the correlation of the questions in each section. The survey questions were divided into the Class Satisfaction section, the Convergence Subject Satisfaction section, and the rest of the questions were sorted into the Curriculum Management Plans section. This survey was

given to students who were taking capstone and convergence classes in a college of engineering. We increased the survey's accuracy by considering various groups of students in different grades and gender as a target.

### *B. Subject of Experiment*

The majors that participated are Telecommunications Engineering, Semiconductor Engineering, and Security Engineering.

The total number of students is 221 students. And the ratio is each 142 students (64.3%), 8 students (3.6%), and 71 students (32.1%). The ratio by grades is 104 freshman students (47,1%), 69 sophomore students (31.2%), 33 junior students (14.9%), and 15 senior students (6.8%). And the ratio by gender is 134 male students (60.6%), and 87 female students (39.4%).

The subjects the students are taking are 26 students in Microprocessor Design (11.8%), 61 students in Programming Project (27.6%), 13 students in Algorithm (5.9%), 38 students in Server Programming (17.2%), 17 students in Capstone Design (7.7%), 50 students in Object-oriented Programming (22.6%), 8 students in Creative Foundation Design (3.6%), and 18 students in System Semiconductor Design (3.6%).

### *C. Development of Questionnaire*

For the survey, we developed the survey questions based on existing research. Survey questions are sorted by Class Satisfaction, Convergence Subjects Satisfaction, and Curriculum Management Plans. The developed survey questions are in Table 1.

TABLE I
SURVEY AND INTERVIEW QUESTIONS

| Class | Questions | Related Research |
|---|---|---|
| Class Satisfaction | I registered for the subjects that I am currently taking because I wanted to study them. | Kye [12] Yu [13], Yu [14] |
| | I think the subjects that I am currently taking are requirements before graduation. | |
| | I want to study more about the subjects that I am currently taking even after the semester ends. | |
| | I enjoy studying the subjects that I am currently taking. | |
| | I would recommend the subjects that I currently taking to my friends. | |
| | I think these subjects are helpful for my major. | |
| | I am overall satisfied with the subjects that I am currently taking. | |
| | I want to continue studying subjects which are like the subjects that I am currently taking. | |
| | I think the number of credits for these subjects is an appropriate amount. | |
| Convergence Subject Satisfaction | I think convergence education is helpful to improve my knowledge in my major. | Shin [15], Kim [16], Yumiko [17] |
| | I think convergence education is helpful to improve cooperation abilities. | |
| | I think convergence education is helpful to improve student relationships. | |
| | I think convergence education is more helpful for my education than other classes. | |
| | I think the class participation rate for convergence education is higher than other classes. | |
| | I think convergence education class is easier to concentrate in than other classes. | |
| | I think convergence education is helpful to improve problem solving abilities. | |
| | I think convergence education should be linked based on level from the lower grade years. | |
| Curriculum Management Plan | What was your interest and expectation when you chose your major? | John [18], Shin [19], Meinald [20] |
| | What do you learn from your major? | |
| | What difficulties have you had while studying your major? | |
| | What are the necessary subjects for your major? | |
| | What subject can be helpful for your major? | |
| | Is a class which allows students to lead and participate a good class? | |
| | Is a comprehensive thinking activity centered class a good class? | |
| | Is a class in which students can interact with each other fully a good class? | |
| | Is a problem-solving centered class which makes students find problems in their daily lives and make the solutions themselves a good class? | |
| | Is a class which applies various education methods a better class than classical lecture? | |
| | Is a class which allows students to fail, learn from this failure, and gives them an opportunity to solve the problem themselves a good class? | |
| | Evaluation for convergence education should be ①absolute evaluation ② | |

| | |
|---|---|
| | relative evaluation ③discretion evaluation by professor. |
| | Convergence education should be offered based on ①semester ②year. |
| | Student should take convergence education subjects ①linked based on level from lower grade levels to higher grade levels ②independently per grade level ③once before graduation. |
| | Convergence education subjects should be run as ①major in-depth courses ② major elective courses ③ general elective courses. |
| | For convergence education subject credits, ①2 credits ②3 credits ③4 credits is appropriate. |
| | For the way of running convergence education class, it should be run as ① theory ②theory + practice ③practice centered. |
| | Among major or liberal arts classes that are not offered as convergence subjects, is there any class which you consider to be a convergence subject? |
| | Would you like to register for a convergence subject class even if it weren't a required subject? Please write why you would or not. |

## III. Results and Discussion

### A. Survey Results

As a descriptive statistics of class satisfaction survey result, table 2 shows the number of responses, minimum, maximum, average, and standard deviation for each of the 9 questions. Every question's average was in between 3.4 to 3.9 and the standard deviation was around point 1 in general, so it is analyzed as "Overall Satisfied".

TABLE II
DESCRIPTIVE STATISTICS OF CLASS SATISFACTION

| Question | N | Min | Max | Mean | SD |
|---|---|---|---|---|---|
| 1 | 221 | 1.00 | 5.0 | 3.4072 | 1.07735 |
| 2 | 221 | 1.00 | 5.0 | 3.7511 | 0.98929 |
| 3 | 221 | 1.00 | 5.0 | 3.6109 | 1.04997 |
| 4 | 221 | 1.00 | 5.0 | 3.4434 | 1.12521 |
| 5 | 221 | 1.00 | 5.0 | 3.6968 | 1.04161 |
| 6 | 221 | 1.00 | 5.0 | 3.9548 | 0.91837 |
| 7 | 221 | 1.00 | 5.0 | 3.7466 | 0.96721 |
| 8 | 221 | 1.00 | 5.0 | 3.4977 | 1.13468 |
| 9 | 221 | 1.00 | 5.0 | 3.7014 | 0.95415 |

To do reliability analysis for each question for class satisfaction, we executed Cronbach alpha analysis and each question's reliability showed high reliability which is 0.939.

Table 3 is a descriptive statistic of the convergence subjects satisfaction survey results, it shows the number of responses, minimum, maximum, average, and standard deviation for each of the 8 questions. Every question's average was in between 3.3 to 3.8 and the standard deviation was around point 1 in general, so it is analyzed as "Overall Satisfied".

TABLE III
DESCRIPTIVE STATISTICS OF CONVERGENCE SUBJECT SATISFACTION

| Question | N | Min | Max | Mean | SD |
|---|---|---|---|---|---|
| 1 | 221 | 1.00 | 5.0 | 3.7240 | 0.91989 |
| 2 | 221 | 1.00 | 5.0 | 3.7104 | 0.95695 |
| 3 | 221 | 1.00 | 5.0 | 3.3303 | 1.06363 |
| 4 | 221 | 1.00 | 5.0 | 3.4887 | 0.95637 |
| 5 | 221 | 1.00 | 5.0 | 3.5430 | 1.05063 |
| 6 | 221 | 1.00 | 5.0 | 3.4434 | 1.02811 |
| 7 | 221 | 1.00 | 5.0 | 3.7195 | 0.95013 |
| 8 | 221 | 1.00 | 5.0 | 3.8416 | 0.98502 |

To do reliability analysis for each question regarding convergence subject satisfaction, we executed Cronbach alpha analysis and each question's reliability showed a high reliability of 0.95. We compared the average of the class satisfaction questions to the average of the convergence satisfaction questions by each major, grade level, and subject, and for all of the questions, there was no meaningful difference from the averages.

Additionally, we analyzed the correlation between the total average of the class satisfaction questions and the convergence subject satisfaction questions. Table 4 shows the correlation results. It showed a meaningful correlation of 0.732**. This suggests that if a student has high class satisfaction, they are likely to have high convergence subjects satisfaction too.

TABLE IV
CORRELATION BETWEEN CLASS & CONVERGENCE SUBJECT SATISFACTION

| Satisfaction | | Class Average | Convergence Subject Average |
|---|---|---|---|
| Class Average | Pearson Correlation | 1 | .732** |
| | Significance Level (Both sides) | | .000 |
| | N | 221 | 211 |
| Convergence Subject Average | Pearson Correlation | .732** | 1 |
| | Significance Level (Both sides) | .000 | |
| | N | 221 | 221 |

### B. Interview Results

To analyze if students have a positive view towards convergence education, we developed interview questions based on the features of convergence subject class activities, and executed interviews. 89.6% of students answered 'Yes'

to the question 'Is a class which allows students to lead and participate a good class?'. 90% of students answered 'Yes' to the question 'Is a comprehensive thinking activity centered class a good class?'. 79.2% of students answered 'Yes' to the question 'Is a class in which students can interact with each other fully a good class?'. 81.9% of students answered 'Yes' to the question 'Is a problem-solving centered class which makes students find problems in their daily lives and make the solutions themselves a good class?'. 85.1% of students answered 'Yes' to the question 'Is a class which applies various types of education methods a better class than the classical way of lecture?'. Lastly, 88.7% of students answered 'Yes' to the question 'Is a class, which allows students to experience failure, lets them learn from failure, and gives them time to solve a problem themselves, a good class?'.

Taken together, 90% of students, which is 199 students out of 221 students, answered that a good class is a class which allows students to lead and participate, is centered around comprehensive thinking activities, allows students to fail, learn from this failure, and gives them an opportunity to solve a problem themselves. Also, about 83% of students answered that a good class is the class which allows students to find problems in their daily lives and make the solutions themselves, and applies various education methods unlike the classical lecture. On the other hand, towards the question 'Is a class where students can interact with each other fully, a good class?', 79.2% (175 students) said 'Yes' and 20.8% (46 students) said 'No'. While this shows positive results in general, it is considered that this question's positive response is low in comparison to other questions, due to worries about problems that can occur during team projects such as unfair levels of contribution and the difficulties of opinion coordination.

Through the interview about the way of running the convergence education curriculum, we investigated students' opinions towards methods of evaluation, how often each class is offered, the interdisciplinary method based on level, how major/in-depth education is run, the adequacy of the credits to complete, and the method of class management, etc.

For the convergence curriculum's subject evaluation methods, absolute evaluation was the highest at 40.4%, relative evaluation was 35.3%, and discretion evaluation by professor was 24.4%. For how often each class was offered, it showed that 45.7% of classes were offered once a year, 30.8% of classes were offered once or twice before graduation, and 23.5% were offered every semester. For the interdisciplinary method based on level, one answer showed a very high result of 52.5% and it was that interdisciplinary education should be run from freshman to senior year. This result suggests that convergence subjects' curriculum should be developed and run in a way so that it is related in between levels and not just independent subjects. For the way of running the convergence education curriculum, 43.9% opened as a major elective course, 28.1% opened as a major in-depth course, 19.9% opened as a general elective course, and 8.1% opened as a liberal arts course. For the credits to complete, the most common answer was that 3 credits was appropriate with 51.6% of responses. For the method of class management, 74.2% answered that theory and practice should be included together during the class. Convergence education does deal with both theory and practice together. And this is one of the reasons why many students answered that they are taking convergence subjects even though it's not a required subject.

## IV. Conclusion

The survey was executed to students from various perspectives such as grade level, gender, etc. who are taking convergence subjects and we analyzed the survey results. One of the most remarkable results is that many students are aware of the necessity of convergence subjects and they show a high satisfaction towards the subjects that allow them to develop their problem-solving abilities. As a result of grade-level analysis, in the survey about capstone subjects' difficulty based on gender, it showed the freshman female students group's average was higher than male students group which means freshman female students group felt capstone subjects were relatively more difficult. As a result of problem-solving ability which is the goal of an engineering education, it showed differences based on group per grade.

There were no differences between the freshman student group and the senior student group. But the result of the sophomore student group's satisfaction was 'Average', and the junior student group's satisfaction was high. We assume that the reason why the result for sophomore student group and junior student group is different, is because for sophomore students, they have to study their major subject deeply for the first time, so it's hard for them to understand the necessity of convergence education. But for junior students who are now used to their major subjects and have to learn subjects which require complicated problem-solving abilities, they can understand the necessity of convergence education. By looking at other questions, it didn't show any differences based on subjects, so we assume that the required problem-solving ability is different per grade. Based on the survey results, it turns out that students who have high satisfaction towards their major classes also have high satisfaction towards convergence education. This result shows that there is a correlation between satisfaction with major classes and convergence classes. And it shows that there is a correlation between major subjects and convergence subjects. Opinions toward convergence education were overall positive. But regarding opinions about the necessity of convergence education, there were various different perspectives from each grade level.

The difference in perspectives wasn't about the necessity of convergence education or curriculum, but it was more about various request about the best way to run a class. For example, freshman and sophomore students said theory centered classes are more necessary, while junior and senior year students said practice centered classes are more necessary. Also, because classes were run as team units, many students expressed problems due to conflict between classmates and they also expressed a need for class contents that support relationship improvement. For senior year students, they had a high demand for subjects that are specialized to employment activities rather than convergence subjects. Many senior year students were aware that convergence subjects are helpful for their employment prospects, but they were also aware that convergence subjects are not enough to get employed, so they requested modification and redevelopment of subjects to address this problem. Based on the research results, we suggest that

subject development regarding employment activities for senior year students is necessary as well as additional research for practical teaching and learning methods. Also customized learning methods of convergence education based on grade and levels for sophomore and junior year students is needed. There are differences based on gender, so it turns out that class content improvement is necessary for fair team composition and evaluation. Also, we suggest a development in teaching and learning methods that are participation centered, not individual centered would be needed.

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