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Abstract

With the emphasis on core competencies in the OECD's Defining and Selecting of Key Competencies (DeSeCo) Project, the University of Seoul in Korea has exerted efforts to reflect the importance of core competencies in the university curricula. At a national level, various tools are being developed to assess the core competencies of the college students. The main assessment tool used in Korea is the Korean Collegiate Essential Skills Assessment (K-CESA), developed by the Korea Research Institute for Vocational Education and Training (KRIVET). This study examined whether the core competencies measured using K-CESA are valid as a tool for assessing educational achievements among college students, and analyzed the correlation between K-CESA scores and course grades. To determine the relationship among core competencies, grades, and Capstone Design assessment scores, the analysis included the Capstone Design course. The validity of the K-CESA was also tested. The purpose of this study was to examine the effectiveness of the concept of competency in engineering education based on courses offered for college students in engineering. The analysis was performed on approximately 200 engineering students at the University of Seoul, so as to minimize the influence of the student variable by limiting the subjects to those of the same major, as well as to verify the effectiveness of engineering education. According to the correlation analysis between core competencies and courses, core competencies were generally shown to be highly correlated to course grades, except in the case of the capstone design course. Between competencies, a high level of correlation was observed between cognitive competencies and non-cognitive competencies. In most cases, there is a correlation between the self-management competency and major-related course grades, indicating that the better a student is at self-management, the more likely he or she is to obtain good grades in major courses. Therefore, self-management can be seen as an appropriate measure of a student's academic diligence. MSC (mathematics, science, and computing) courses were shown to be related to the resource & information use competency and the higher order thinking competency. MSC courses are basic courses in the STEM (science, technology, engineering, and mathematics) majors that are related to competencies in utilizing the given information and drawing conclusions. This shows that MSC courses are well designed to enhance basic core competencies. Combining these findings, this study confirmed that the K-CESA tool has a certain level of correlation with academic performance and functions as one of several ways to evaluate the program outcomes of engineering education accreditation.

Keywords: DeSeCo Project, Core Competency, K-CESA, Course Grades, Capstone Design, MSC, Correlation

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Introduction

In the recent years, the importance of core competencies in university education has been increasingly emphasized, and many tools to diagnose core competencies are being developed. Generally, the term core competencies is used to refer to a comprehensive concept encompassing knowledge, skills, and attitudes that are used to solve problems in various situations, rather than a narrow set of knowledge and skills that are only applicable to specific fields (Jin et al., 2011). With the coming of the era of lifelong learning, this term is used to indicate a set of common and basic skills that anyone can apply to their own lives (Choi et al., 2008). Reflecting this understanding of core competencies, the Korean Ministry of Education and the Korea Research Institute for Vocational Education & Training developed a core competency diagnostic tool called K-CESA (Korea Collegiate Essential Skills Assessment) for university students. This tool classifies core competencies into six categories and is used in many tests to diagnose core competencies (Jin et al., 2011). According to the information found in an extensive literature review, although there are many core competency diagnostic tests currently in use in Korea, there is a lack of specialized tools to diagnose the core competencies of university students. The majority of the tools in existence have been developed by individual universities to gauge the competencies that fit with the identity of the university. Therefore, in reality, the K-CESA core competency diagnostic test can be seen as the only core competency diagnostic test for university students currently being used in Korea (Son et al., 2015).

In this study, the correlation between K-CESA competency scores and course grades for Capstone Design was analyzed in order to examine the possible uses of the K-CESA competency scores as indicators of academic performance. As a variety of factors influence competency, this study limits its scope to engineering students at the University of Seoul, so as to eliminate individual bias as much as possible. There are relatively few existing studies that analyze the correlation between course grades and competencies. This is because academic abilities in these studies were not measured by course grades but by the comprehensive concept of competencies, leading to a lack of interest in the relationship between course performance and competencies (Choi et al., 2009). Going back to the concept of competencies, discussed earlier, competencies encompass the knowledge, skills, attitudes, etc., necessary for acting as a member of society. However, from the perspective of universities, competencies are the result of university education. In other words, they are a kind of learning outcome. If competencies can be fostered by universities, it means that they can be evaluated and trained through education. However, there has been a lack of research on core competencies as measures of learning outcomes at universities due to a lack of maturity of academic interest in the core competencies of university students (Choi et al., 2009).

This study recognizes this limitation in existing research and aims to explore the relationship between courses and competency. Because the University of Seoul has been carrying out an engineering accreditation program

(ABEEK) since 2006, and because the aim of the accreditation program is to enhance core competencies, research targets were selected from engineering students at this university. In other words, the University of Seoul has selected core competencies as a trait that should be fostered in its university education and has been evaluating core competencies through the K-CESA diagnostic test.

The aim of this study is to examine the case of the University of Seoul to verify whether the K-CESA core competency diagnostic test is a suitable tool for measuring the competencies of students in the engineering accreditation program.

Theoretical Background

Core Competencies

Core competencies refer to common and fundamental abilities for living as members of society in the era of lifelong learning. Rather than the knowledge and skills required in specific fields, the term ‘core competencies’ is used as a comprehensive concept encompassing knowledge, skills, and attitudes for problem-solving in a variety of situations (Jin et al., 2011). Competency has been defined in many different ways in the existing studies and the concept is still in the process of evolution (Choi et al., 2008).

According to Spencer & Spencer (1993), competencies refers to intrinsic characteristics of an individual that lead to effective and outstanding performance in specific situations or tasks according to the given criteria. Norton (1999) defined a competency as an achievement of knowledge, skills, and attitudes required to perform a given task. Hwang et al. (2004) define core competencies as core abilities required to perform tasks successfully.

The global emphasis on competency and the expansion of the meaning of this term to lifelong competencies began with the OECD’s DeSeCo (Definition and Selection of Competence) Project. In the DeSeCo Project, competency was viewed as a comprehensive set of abilities for a variety of situations in life, and core competencies were defined as all abilities required to solve problems faced in the various environments that an individual may be placed in (OECD, 2005).

In Korean, communication ability, mathematical ability, problem solving ability, self-improvement ability, resource management ability, human relations ability, information ability, technological ability, organizational understanding ability, and work ethics were selected as elements of core competencies in the process of establishing the national competency standards.

A study conducted by KEDI (the Korean Educational Development Institute) presents basic reading comprehension, core abilities (communication, problem solving, self-directed learning, leadership), civic awareness, and job-specific abilities as fields of core competency (Yoo et al., 2002). Oh’s study (2006) analyzed research from Korea and other countries to identify the core competencies required from adults and defined the following: basic reading comprehension, basic job skills, professional skills, ability to switch careers, civic awareness, and recreational abilities.

Core Competencies of University Students and K-CESA

The introduction of the concept of core competencies to higher learning can be traced to a change in the requirements posed by society to universities. As society has evolved, helping individuals obtain professional skills has become an important role of universities. Fostering the development of core competencies in students has become the new focus of higher learning (Klieme et al., 2004; Park, 2008).

The tools and areas used to evaluate the core competencies of university students differ slightly from those used for ordinary adults. For example, the OECD's AHELO (Assessment of Higher Education Learning Outcomes) is a project conducted for the international measurement and comparison of higher learning outcomes. This test is comprised of two parts: one evaluating general core competencies such as thinking skills, inference skills, and problem-solving skills, and the other evaluating discipline-specific skills. The Collegiate Learning Assessment (CLA), used in the U.S. as a major collegiate learning outcomes assessment tool, is a comprehensive measure of critical thinking, analytical logic, writing, and communication competency, and of the abilities to interpret, analyze, and compile information.

The Korea Collegiate Essential Skills Assessment (K-CESA) is the most well-known core competency diagnostic test for university students conducted in Korea. This test defines six elements of the core competencies: communication, resource and information use, higher-order thinking, global competency, human relations, and self-management; these are used to diagnose the core competencies of university students. The definitions of the six areas and measurement methods are presented in Table 1. The test is multiple choice, taking 5 hours and 30 minutes to complete. The scores of four sections—global competency, resource and information use competency, human relations competency, and self-management competency are graded automatically and can be seen by the test taker once the test is complete. The communication competency and higher order thinking sections require test takers to submit essays and audio recordings. These sections take some time to grade and the scores are only available afterwards.

Table 1. *Definitions and Measures of K-CESA Core Competencies*

Area	Definition	Questions	Question Type	Test Duration (min)
Communication Competency	Traditional listening, reading, writing, and speaking skills combined with mediation skills for conflict resolution, something that has been emphasized recently	32	Multiple choice and performance assessment	78
Global Competency	International sensibility, attitude, and other skills required in the era of globalization	38	Multiple choice	30
Higher order Thinking Competency	Higher order thinking ability to clarify and recognize a problem, use inferences to solve the problem, evaluate ideas based on criteria, and present the most suitable solution	8	Performance assessment	90
Resource & Information use Competency	Ability to collect, analyze, and utilize time, budget, human resources, material resources, textual, numerical, and pictorial information and ICT, science and technology, equipment manipulation skills etc.	30	Multiple choice	45
Human Relations Competency	Understanding of emotional solidarity, cooperation, mediation, leadership, and organizations necessary to achieve common goals in various human relationships and social situations	50	Self-evaluation (5 point scale)	No limit
Self-Management Competency	Ability to diagnose problems and exercise self-discipline to solve the problem, including self-directed learning, planning and execution, professionalism, and emotional self-control skills	60	Self-evaluation (5 point scale)	No limit

Engineering Accreditation (ABEEK) and Accreditation Criteria (Program Outcomes, Curricula)

The Korean system of engineering accreditation began with the establishment of the Accreditation Board for Engineering of Korea (ABEEK) in 2000; this system uses the U.S. Accreditation Board for Engineering and Technology (ABET) as a model and promotes engineering education and produces engineering professionals needed by industries and the society. With new recruit hiring criteria of large companies having shifted recently from qualifications to job performance ability, the focus has been aligned with the objectives of the engineering accreditation system: demand-focused education and outcomes-based education.

The engineering accreditation system presents accreditation criteria that allow outstanding education programs to be recognized from the perspective of their consumers – students and corporations—moving away from existing university evaluation systems, which have been focused on rankings. However, just like traditional university evaluations, the educational outcomes or effects of the engineering accreditation program have not been actively studied in a quantitative manner. On the contrary, university management bodies have been raising doubts about the effectiveness of engineering accreditation compared to the time and effort invested in its operation, leading some universities to give up their accreditation programs (Kim et al., 2015).

The University of Seoul began its engineering accreditation program in 2006, producing the first batch of accredited graduates in February 2012. As of 2016, the engineering accreditation program is being operated in seven departments. However, there are eleven engineering departments in the University of Seoul, meaning that only 64% of the students are enrolled in the engineering accreditation program. Even departments operating accreditation programs have different graduation requirements for students in the accreditation and non-accreditation programs (non-accreditation program students do not have to take some liberal arts and design courses). Thus, there is a lack of research on the effects of a unified student competency evaluation and accreditation system covering all engineering disciplines.

The KEC 2015 engineering accreditation system established accreditation criteria (program educational objectives, program outcomes, curricula, students, faculty, educational environment, program improvement, and program criteria for each discipline) for program operation and evaluation. The program outcomes are outlined in Table 2, defining the knowledge, skills, and attitudes that students should be equipped with by the time of graduation.

Table 2. *Definitions of Program Outcomes in KEC2015*

No.	**Program Outcomes**
PO1	Ability to apply knowledge of mathematics, basic science, engineering, and information technology to solutions of engineering problems
PO2	Ability to analyze data and experimentally verify the given facts or hypotheses
PO3	Ability to define and formulate engineering problems
PO4	Ability to apply the latest information, research-based knowledge, and appropriate tools to solutions of engineering problems
PO5	Ability to design systems, components and processes within realistic constraints
PO6	Ability to contribute to project team output to solutions of engineering problems
PO7	Ability to communicate effectively under diverse situations
PO8	Ability to understand the impacts of engineering solutions in the context of health, safety, economics, environment, and sustainability.
PO9	Ability to understand professional ethics and social responsibilities as an engineer
PO10	Recognition of the need for, and an ability to engage in life-long learning in the context of technological change

The curriculum criteria in the KEC2015 requires curricula to be set up and sustained to achieve program outcomes outlined in Table 2. It also requires systematic operation and design of programs to allow students to satisfy the minimum course credit requirements as outlined in Table 3.

Table 3. *Program Criteria in KEC2015*

Course type	**Completion criteria**
Liberal arts	Major-related liberal arts courses required for the achievement of program outcomes
MSC	Minimum of 30 credits of mathematics, basic sciences (experiments may be included), and computing (Computing course credits are recognized up to six credits)
Engineering sciences	Minimum of 54 credits of engineering and related topics including design, experiment, and practice components (The design component must include an entry-level design course, element design course, and a capstone design course)

Combining the above accreditation criteria, program outcomes aim to measure student abilities beyond the curriculum areas, course credits, and grades. A separate evaluation tool is required to measure how far the objectives of each program have been met. The University of Seoul thus has come to utilize the course embedded assessment in the Capstone Design and experiment subjects together with the direct diagnostic tool K-CESA as a measure of the program outcomes.

Data for Analysis

The data used in this study is from engineering students at the University of Seoul who took the K-CESA in 2015. There were a total of 218 students who took the K-CESA in 2015. After eliminating thirteen students who returned incomplete sections or insincere responses, 205 students were initially selected for the analysis. Next, information on the personal background (sex, grade, area of residence, registration status, accreditation status, etc.) of each student was obtained together with course completion information (grade for each course) with cooperation from the university. Here, one case was eliminated as a mismatch in personal information, leaving 204 respondents as the final target of the analysis. Table 4 presents more detailed information on the targets of the study.

Table 4. *Personal Background Data of Survey Respondents*

Category	Classification	Frequency (N)	Ratio (%)	Category	Type	Frequency (N)	Ratio (%)
Sex	Male	133	65.2	Department, School	Dept. of Architecture	47	23.0
	Female	71	34.8		Dept. of Geo-Informatics	4	2.0
Region	Capital metropolitan area	95	46.6		Dept. of Transportation Engineering	3	1.5
	Others	99	48.5		Dept. of Mechanical and Information Engineering	5	2.5
	Missing data	10	4.9		Dept. of Civil Engineering	3	1.5
Grade	1	3	1.5		Dept. of Materials Science and Engineering	46	22.5
	2	25	12.3		School of Electrical and Computer Engineering	32	15.7
	3	26	12.7		Dept. Landscape Architecture	6	2.9

	4	150	73.5		Dept. of Computer Science and Engineering	8	3.9
Registration status	Graduated	52	25.5		Dept. of Architectural Engineering	4	2.0
	Undergrad	136	66.7		Dept. of Chemical Engineering	8	3.9
	Academic leave	16	7.8		School of Environmental Engineering	38	18.6
Accreditation	Accredited	124	60.8	Total		204	100.0
	Non-accredited	80	39.2				

Table 5. *Basic Statistical Values for Each Variable*

	N	Min.	Max.	Mean	SD
Combined GPA	204	2.18	4.39	3.39	.466
Liberal arts GPA	204	0.00	4.34	3.29	.538
Major GPA	204	0.75	4.46	3.42	.533
Combined design GPA	189	0.75	4.50	3.51	.613
Basic design GPA	158	2.00	4.50	3.74	.612
Element design GPA	168	0.75	4.50	3.41	.676
Capstone design GPA	107	2.50	4.50	3.87	.565
MSC GPA	159	1.87	4.45	3.30	.551
Major-related liberal arts GPA	161	1.97	4.50	3.27	.493
Self-management competency	204	25.70	79.00	50.28	9.382
Human relations competency	204	25.25	76.32	52.41	9.362
Resource & information use competency	203	31.80	75.94	56.32	7.948
Global competency	202	31.24	73.55	52.94	7.904
Communication competency	95	30.50	77.29	53.23	10.329
Higher order thinking competency	196	31.28	76.00	52.59	7.635

Looking at Table 5, the combined GPA of all the students is 3.39, while the liberal arts course GPA is 3.29 and the major course GPA is 3.42, showing slightly higher grades for major courses. GPA for combined design courses is quite high at 3.51, with a 3.74 GPA for basic design, 3.41 for element design, and 3.87 for capstone design. The GPAs for basic design and capstone design are relatively higher than that for element design. MSC GPA was slightly lower than average at 3.30, as was the GPA for major-related liberal arts courses, at 3.27.

Competency scores are presented as T scores with 50 points as the average and a standard deviation of 10 points. The score for self-management competency was the lowest at 50.28 while the sore for resource & information use competency was the highest at 56.32. Scores for other competencies are distributed in the range of 52-54.

Method of Analysis

This study used the correlation analysis to understand the correlation between university course grades and the students' core competencies. The first was the correlation analysis to analyze the correlations between the course grades and between the respective core competencies, followed by the correlation between course grades and core competencies. This was used to understand the relationship between the respective course grades and core competencies.

Results of Analysis

The first analysis was a correlation analysis between the respective course grades, between the respective core competencies, and between course grades and core competencies. Table 6, Table 7, and Table 8 present the correlations between the two groups of variables.

Table 6. *Results of Correlation Analysis Between Course Grades*

	Combined GPA	**Lib. arts**	**Major**	**Comb. design**	**Basic design**	**Element design**	**Capstone design**	**MSC**	**Major li. arts**
Combined GPA	1								
Lib. arts	.758**	1							
Major	.879**	.522**	1						
Comb. design	.730**	.452**	.870**	1					
Basic design	.309**	.261**	.336**	.450**	1				
Element design	.779**	.456**	.877**	.952**	.196*	1			

Capstone design	.305**	.151	.347**	.466**	.219*	.237*	1		
MSC	.869**	.836**	.710**	.510**	.236**	.558**	.104	1	
Major lib. arts	.673**	.794**	.475**	.351**	.245**	.306**	.174	.641**	1

Table 7. *Results of Correlation Analysis between Core Competencies*

	Self-management	Human relations	Resource & information use	Global	Communication	Higher order thinking
Self-management	1					
Human relations	.718**	1				
Resource & information use	-.021	.011	1			
Global	.101	.213**	.228**	1		
Communication	.194	.141	.432**	.330**	1	
Higher order thinking	.136	.085	.521**	.182*	.319**	1

Table 8. *Results of Correlation Analysis between Course Grades and Core Competencies*

	Comb.	Lib. arts	Major	Comb. design	Basic design	Element design	Capstone design	MSC	Major lib. arts
Self-management	.251**	.126	.229**	.213**	.157*	.215**	.124	.139	.141
Human relations	.127	.037	.127	.090	.110	.106	.141	.035	.002
Resource & information use	.031	.055	.014	.047	-.017	.067	.070	.175*	.018
Global	-.035	-.055	-.018	.011	.016	.040	.052	-.043	.027
Communication	-.007	-.009	.002	-.013	.072	-.038	N/A	-.058	.097
Higher order thinking	.117	.082	.045	.029	.062	.023	-.003	.204*	.094

Looking at Table 6 first, the correlations can be observed between most courses. The only exception is in the capstone design course. Capstone design was shown to be unrelated to liberal arts, MSC, and major-related liberal arts courses, which is revealing of the nature of the subject. As capstone design deals with highly specific issues within the major, it shares little in common with liberal arts courses.

Looking at the correlations between the competencies shown in Table 7, the correlation between self-management competency and human relations competency was significantly higher, at .718, while the resource & information use competency and higher order thinking competency also had a meaningfully higher level of correlation of .521. In general, the resource & information use competency had higher levels of correlation with other competencies. These results somewhat reflect the structure of the six competencies designated in the K-CESA. The K-CESA classifies the self-management competency and human relations competency as non-cognitive (affective) competencies and the resource & information use competency, global competency, communication competency, and higher order thinking competency as cognitive competencies. These results show that this classification is justified to a considerable extent.

Looking at the correlation between course grades and the competencies shown in Table 8, it can be seen that the competency related to the greatest number of courses is the self-management competency. The self-management competency is shown to be meaningfully related to the grades of most major courses, showing that the self-management competency is related to basic academic abilities in engineering majors. On the other hand, it is shown to be unrelated to grades in liberal arts courses, and also unrelated to the grades in the Capstone Design, the course with the highest level of concentration on the specific discipline. It can be seen that academic ability on a more basic level of specific disciplines is related to the self-management competency. As the self-management competency refers to an attitude of self-restraint and focus on academic pursuits, a relationship between this affective competency and major course grades can be seen.

Meanwhile, the GPA for MSC courses appears to be meaningfully related to the resource & information use competency as well as to the higher order thinking competency. Although MSC courses are actually classified at liberal arts courses, they are like an introduction to the major courses for engineering students. As mathematics, science, and computing are tools for utilizing given information and catching the meanings contained within the data, there is a strong correlation with the resource and information use competency. The higher order thinking competency also deals with utilizing given information to draw conclusions, and thus the correlation can be understood in the same vein.

Core competencies refer not to the abilities for a specific line of work but to a more general set of abilities. In this context, the content of MSC courses is closer to the substance of the general competencies, while the major courses are intended to train more specific competencies. Therefore, the fact that the results show a significant level of correlation between MSC courses and competencies is quite natural.

Conlusion and Discussion

This study aimed to explore the relationship between university courses and core competencies by conducting K-CESA diagnostic tests for engineering students from the University of Seoul and comparing the results with their respective course grades to observe correlations from various perspectives. According to the correlation analysis, performance in most courses was highly correlated with that in other courses, with the exception of the Capstone Design course; a high level of correlation was observed among cognitive competencies and non-cognitive competencies. Between course grades and competencies, high levels of correlation were observed between self-management competency and most major courses. This implies that a student with higher self-management competency is more likely to obtain good grades in her chosen discipline. Therefore, the self-management competency can be seen as a suitable measure of a student's diligence. MSC courses were shown to be meaningfully related to the resource & information use competency and the higher order thinking competency. MSC courses deal with mathematics, science, and computing, which form the foundation of the engineering disciplines and are closely related to competencies in utilizing given information and forming comprehensive conclusions. Therefore, students who show lower levels of competency in resource & information use or in higher order thinking can be directed to take MSC courses that enhance fundamental knowledge and skills. In this way, MSC courses can act as academic training that enhances basic core competencies. Summing up the results of the study, there is to a certain extent a correlation between the K-CESA tool and academic courses, and the K-CESA functions as one method of evaluating the achievement of program outcomes in the engineering accreditation system.

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