An Use of Course-Embedded Assessment for Assessing Program Outcomes

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Abstract — *According to KEC 2005 of Accreditation Board for Engineering Education of Korea, criterion 2 defines twelve program outcomes which specify the knowledge, skills, and attitudes which students of a program should meet at time of graduation. To demonstrate achievement of program outcomes, target level of outcomes should be established and appropriate tools for assessing those outcomes should be selected. As program outcomes can be fostered throughout curriculum and each course may have one or more of related program outcomes, we wanted to find a way to use course outcomes to review the extent which program outcomes are achieved through courses at a specific point as a milestone as well as other purposes before graduation. Even though course-embedded assessment except using capstone design course is not proved to be a formal adequate method for assessing program outcomes, we tried a course-embedded assessment procedure to work products of a design course and found its possibility to assess program outcomes as a means of reviewing an intermediate achievement level of program outcomes.*

Index Terms — *accreditation, course-embedded assessment, program outcomes, course learning outcome*

INTRODUCTION

The accreditation for engineering education by Accreditation Board for Engineering Education of Korea (ABEEK) emphasizes outcome- based education which focuses on what students have abilities rather than what teachers teach them. It also requires continuous quality improvement which evaluates outcomes and then uses them for the systematic improvement in the engineering education. For this purpose, a systematic and effective management of the outcome assessment at program or course level is required, and measures and evidence that indicate the degree to what criteria is met should be developed. According to KEC2005 criteria published by ABEEK, engineering programs must show that all students should demonstrate achievement of twelve program outcomes listed in criterion 2 as follows[1];

(1) an ability to apply knowledge of mathematics, science, engineering and information technology;
(2) an ability to design and conduct experiments, as well as to analyze and interpret data;
(3) an ability to design a system, component, or process to meet desired needs within realistic constraints;
(4) an ability to identify, formulate, and solve engineering problems;
(5) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice;
(6) an ability to function on multi-disciplinary teams;
(7) an ability to communicate effectively;
(8) a recognition of the need for, and an ability to engage in life-long learning;
(9) a broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;
(10) a knowledge of contemporary issues;
(11) an understanding of professional and ethical responsibility;
(12) an understanding of world culture and an ability to cooperate internationally.

Those program outcomes are statements that describe what students are expected to know and be able to do by the time of graduation. These are related with the skills, knowledge, and behaviors that student can acquire through the curriculum and extra curriculum in the program.

To demonstrate achievement of program outcomes, target level of outcomes should be established according to a level which reflects the needs of constituencies and appropriate tools for assessing those outcomes should be selected. Also, a minimum level of outcome achievement for individual student should be established. ABEEK requires a rigid system for the program outcome assessment and this strict nature of the assessment system has been a source of frustration to engineering faculty and staffs to prepare and implement the assessment plan.

Our program outcome assessment system made up of four elements; (1) Performance criteria which are statements that clearly define how performance will be measured and the criteria that suggest success or lack of success in reaching the desired outcomes (2) Assessment tool which assess outcomes efficiently. This tool may be Capstone design projects, Student portfolio, Exit Interview and Exit Survey (3) Rubrics which are sets of criteria or scoring guides that define what is expected of students. Rubrics allow for standardized evaluation according to specified criteria, making grading simpler and more transparent (4) Closing the loop which defines implementation strategies or methods to foster the corresponding outcomes and improvement plan if the outcome target is not achieved. If one of these elements in the system was not clearly defined or missed, it had to be revised.

Our computer engineering program assessed all twelve program outcomes using the assessment system for two years[11]. The assessment was conducted in the second semester of senior. After the assessment, we came to find some problems and issues to be solved. The first one is that there was much overhead due to a limited time as most of outcomes had to be assessed in one day or two days. It is found through our two years experience that current assessment system required much effort to assess all program outcomes during a short period. The second one is that we needed any useful methods for checking the level of outcome achievement before the final outcome assessment which was usually conducted around the time of graduation. For example, we wanted have any opportunities to make up the lacks or deficiencies of outcomes if they do not reach the satisfied level. The third one is that it may be better to assess a program outcome through courses because it does not require extra student time and student motivation would be high because the assessment activity is related with grade scoring. For example, outcome (2)- which is an ability to design and conduct experiments- can be assessed using courses including labs. To address these problems, we considered an option to select course-embedded assessment method.

As program outcomes can be fostered throughout curriculum and each course may have one or more of the related program outcomes, we decided to assess course learning outcomes to measure the extent which program outcomes is achieved in the courses at any point as a milestone before graduation. Even though course-embedded assessment except using capstone design course is not proved to be a formal adequate method for assessing program outcomes because there are no convincing data which indicate successful applicability without any issues as discussed in [3], we tried a course-embedded assessment procedure to work products of a design course and to find its possibility to assess program outcomes as a means of reviewing an achievement level of program outcomes.

Program outcome assessment using capstone design course

The objectives of the capstone design course are to provide a practical and professional design experiences and to use it as the tools for observing their design abilities. The overview of our capstone design course is described as follows.

- **Course title**: Project(I), Project(II), 3 credits each.
- **Project type**: self-determined or very few projects sponsored by company.
- **Assessment procedure**: managers or senior developers from company and advising professors are participated. Rubrics are used[11].
- **Related program outcomes**: program outcome (2), (3), (4), (5), (6), (7).

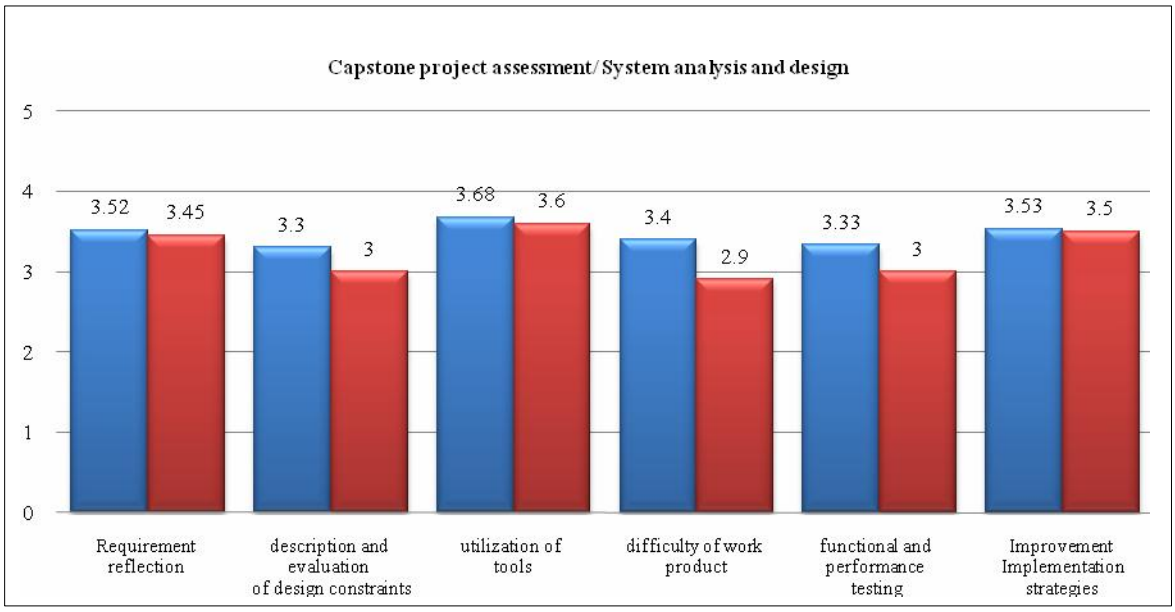

Figure 1 The results of capstone project assessment

Program assessment using capstone design course was conducted by a manager or senior developers(sometimes CEO) from industry and advising professors using rubrics. Students had to present a work product that they developed in capstone projects as a team. The rubric items used to assess program outcome (3) are requirement reflection, description and evaluation of design constraints, utilization of tools, difficulty and completeness of work product, functional and performance testing, suggestions of improvement implementation strategies.

The outcome achievement target was accomplished in that sixty percent of the students will score 3 or higher on the rubrics related to work product demonstration as shown in Figure 1. However, the score of 'description and evaluation of design constraints' item was low so we judged that design education for creating alternative designs according to design constraints and evaluating each one should be complemented and enhanced in the lower course. It was found that difficulty level of some work products was low than we expected even though it satisfied our minimum level. In addition to this, a method and procedure to conduct functional and performance testing about products should be complemented. A student survey was also conducted to find improvement and to compare this result with capstone assessment result. The current survey content asks students to compare their abilities before and after capstone projects. In addition to this content, we surveyed how well design courses prior to capstone course prepared student to perform projects.

Course-embedded assessment

Capstone project is a good tool for assessing program outcome, but we have encountered some issues when applying this project to program outcome assessment. There have been needs of any useful methods for checking the level of outcome achievement before the final outcome assessment which is conducted around the time of graduation. For example, we wanted have any more opportunities to make up the lacks of outcomes even if they pass the established level. Determining outcome achievement level is not easy task since this should be an acceptable level to the program reflecting the requirement of constituency. In addition to this, it requires a lot of trial to obtain an adequate achievement level. One thing further to review is that outcome (2) which is an ability to design and conduct experiments, for example, is desirable to be assessed using the courses including labs rather than using other assessment tool. However, the assessment of program outcomes using any courses except capstone design course has not been considered appropriate method so that we attempted to use course-embedded assessment as a means of assessing some of program outcomes. Many studies showed experiences using this assessment method and also described pros and cons of it [3,6,7].

Course-based assessment, sometimes called embedded assessment or authentic assessment, is based on identifying and acquiring student work within specific courses that best relates to specific program outcomes. Course-based assessment is effective and efficient because it allows faculty to use actual assignments, tests, projects, and papers for program assessment[2,8]. Two key terms such as course outcomes and course learning objectives are needed to be defined for our purpose as shown in [3]. Course outcomes are knowledge, skills, and attitudes that the students who complete a course are expected to acquire. Some of the outcomes in core courses should map onto or be identical with one or more program outcomes. Course learning objectives are statements of observable student actions that serve as evidence of the knowledge, skills, and attitudes acquired in a course[9].

A basic procedure of course-embedded assessment which we have experienced in applying it is as follows.

1. Selection of courses. As there are one or more courses, the identification of which courses was assessed is through agreement at program committee. This committee selected the course which best map learning outcomes of a course onto program outcomes. There are one basic engineering design course, diverse elementary design courses and two capstone courses in our design course sequence. The basic course and capstone course are core courses and other courses are elective courses. We have chosen 'system analysis and design' course to apply course-embedded assessment to check the achievement of program outcome (3) which is an ability to design a system, component, or process to meet desired needs within realistic constraints. To select the course, a course mapping table like table 1 showing course outcomes mapped onto program outcomes is used and this information is extracted from the course syllabus[8].
2. Assessment tool for each course learning outcome. In order for one to evaluate the extent to which a learning outcome has been met, student work products were identified. These are project proposal, technical development documents, written presentation materials. Same scoring rubrics are used to assess work products of capstone projects were applied.

A grading strategy which is consistent with the outcome achievement level is needed for course-embedded assessment to be more effective as shown in [4]. The methods suggested in [10] were used to map a outcome achievement to course grade.

3. Development of a complete list of course embedded assessment for all the program outcomes.

The mapping table including course learning objective, assessment criterion, targeted achievement level, related program outcomes was built. The course-embedded assessment can be designed in such a way that if course learning outcomes are demonstrated successfully, then the achievement of program outcomes is assured.

4. Evaluation and collection of learning outcomes data.

According to course-embedded assessment system, we have evaluated 'system analysis and design ' course for checking the achievement level of a design capabilities program outcome. Four course outcomes are assigned to this course and two outcomes are described in Table 2 and those course outcomes are related with one or more program outcomes.

Course title	Outcome element	Course learning objective	Assessment criterion	Target of Achievement level	Related Program outcomes
system analysis and design	Reflection of business and technical requirements	(1) to create and evaluate alternative designs.	Evaluate design constraints according to business and technical requirements	50% of students scored 70 or higher on 'design document'	Program outcome (3)
	Tool use	(2)to implement software component using appropriate tool	Implement efficient software component source code	50% of students scored 70 or higher on source code quality	Program outcome (5)

Table 1 course mapping table

Assessment results for two years indicated two things; it is required to improve a method for creating alternative designs according to the change of design requirements. Also, an implementation strategy which reflects design constraints should be devised. These results show similar results as shown in Figure 1 so that we can use course embedded assessment as a milestone for reviewing program outcome.

Conclusions

The objective of assessing course learning outcomes is to improve lacks of course outcomes, teaching method to help students to attain a performance target, course content and to assign course grade. In addition to assessing course outcomes, it is also necessary to assess outcomes at program level. However, it is not easy task because of many factors occurred during the assessment. Program outcomes can be fostered throughout curriculum and each course may have one or more of the related program outcomes, we wanted not only to find a way to use course learning outcomes to assess program outcomes, but also to review the extent which program outcomes are achieved through courses at specific point as a milestone before graduation. To use course outcomes for the program outcomes assessment, these courses have to equip necessary conditions enough to assess program outcomes. One method for doing this is to use course embedded assessment technique. Even though it is not proved to be a formal adequate method for assessing program outcomes, we applied this method to a design course and obtained course outcome achievement data. It was found that this data was effectively used to review an intermediate achievement level of program outcome criterion 3.

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