An Use of Course-Embedded Assessment for Assessing Program Outcomes

YoungTaek Jin, KiHong Ahn, ByoungWook Choi

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 used. 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 to apply course-embedded assessment to work products of a design course and found its possibility to assess program outcomes as a means of reviewing an achievement level of program outcomes.**

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

I. 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 has been met should be demonstrated. According to KEC2005 criteria published by ABEEK, engineering programs must show that they 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;

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(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 students 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 such as industry and appropriate tools for assessing those outcomes should be selected and used. Also, a minimum level of outcome achievement for individual student should be established. ABEEK requires a very 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 consist of four elements; (1) Performance criteria and level 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 directly. This tool may be Capstone design projects, Student portfolio, Exit Interview and Exit Survey. Only indirect tool such as student survey is not recognized as adequate tool (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. Analytic and holistic rubrics can be used, but they have good characteristics for the assessment (4) Closing the loop which defines implementation strategies or methods to foster the corresponding outcomes and

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improvement plan if the outcome target is not achieved. If one of these elements in this system was not clearly defined or missed, it had to be corrected under accreditation visit.

Our computer engineering program assessed all twelve program outcomes using the assessment system for two years[2]. The assessment was conducted in the second semester of senior. Through the assessment, we came to find some problems and issues to be improved. The first 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 require much effort to assess all program outcomes during a short period. The second 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 a lot of opportunities to make up the lacks or deficiencies of outcomes if program outcomes do not reach the satisfied level. The third is that it may be better if program outcomes can be assessed using courses because it will not require extra teacher and student time. Also, student motivation would be high because the assessment activity is related with grade scoring. For example, it would be desirable that program outcome (2) which is an ability to design and conduct experiments can be assessed using courses including labs. These issues and other research[3][4] motivated our study which utilize course-embedded assessment method.

As program outcomes can be fostered throughout curriculum and each course may be related with one or more program outcomes, we tried to find a way to use course learning outcomes to measure program outcomes. Even though course-embedded assessment for any courses 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 have found possibility to assess program outcomes using course learning outcomes through course-embedded assessment. However, many conditions should be satisfied to apply it to the assessment of program outcomes.

II. Program Outcome Assessment Using Capstone Design Course

A capstone design shows culminating design experience and it is representative course for course embedded assessment. 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 design abilities of students. The overview of our capstone design course is described as follows.

- **Course title**: Project(I), Project(II), 3 credits each.
- **Project type**: any kinds of software and hardware system. Self-determined or very few projects sponsored by company.
- **Assessment procedure**: managers or senior developers from company and advising professors take part in the assessment using rubrics[2].
- **Related program outcomes**: program outcome (2), (3), (4), (5), (6), (7).

Program outcomes assessment using capstone design course is conducted by a manager or senior developers(sometimes CEO) from industry and advising professors. Students have to demonstrate design products 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 design products, functional and performance testing, suggestions of improvement implementation strategies.

The outcome achievement target was established that sixty percent of the students will score 3 or higher on the design product demonstration as shown in left bars in Fig. 1. However, the result value of 'description and evaluation of design constraints' item was low so we judged that design education for creating alternative designs according to design constraints should be complemented and enhanced in the lower division of design course sequence. Also, it was

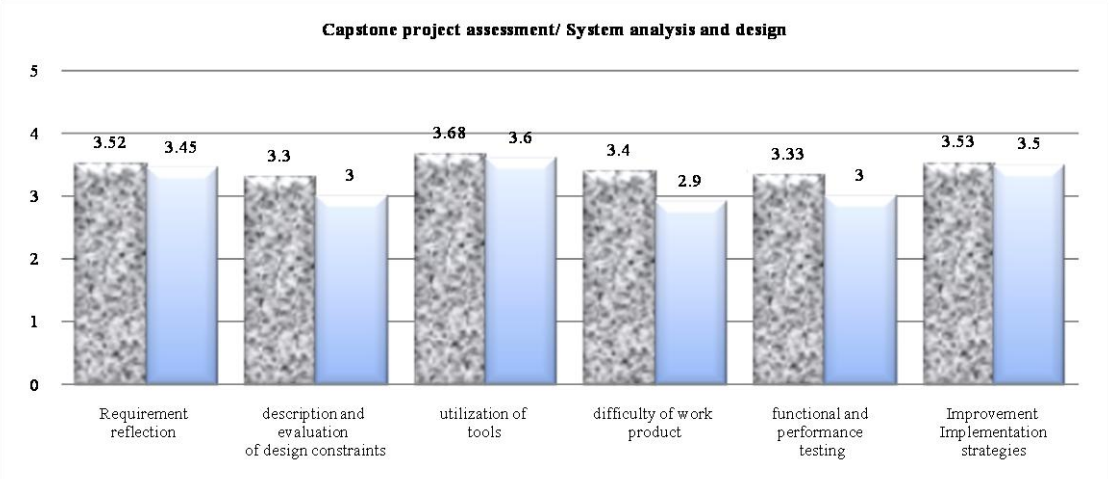

Figure 1 comparison of assessment between capstone project and a design course

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 self-assessment result with capstone assessment result. The current survey 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. Then, we utilized this survey result to find which part of design education such as teaching technique, design contents and design process need improvements.

III. COURSE-EMBEDDED ASSESSMENT

Capstone project is a good tool for assessing program outcomes, but we have encountered some issues when applying this project to program outcome assessment. One of those issues is that proactive improvement was hard because assessment was conducted at the near time of the graduation. There have been need of any useful methods for checking the level of outcome achievement before the final outcome assessment which is conducted at later part of the second semester of senior. For example, we wanted to provide students more opportunities with making up the lacks of the outcome even if the program outcome met 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 experiences 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 have shown experiences using this assessment method and also described pros and cons of it [3][5][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 proved to be effective and efficient because it allows faculty to use actual assignments, tests, projects, and papers for program assessment[8][9][10][11][12][13]. 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[14].

In order to apply course-embedded assessment to the assessment of program outcomes, we summarized many conditions which should be satisfied. The first is that a course to be used in assessing program outcome should be placed on upper division of a course sequence which presents accumulated learning outcomes. The second is that there should be selection criteria determining one or more courses which serves well to assess the corresponding outcome if there are multiple courses related with the program outcome. The third one is that same rubrics and same assessment criteria should be applied to any courses used in this assessment. Many studies[15][16][17] have shown the steps and methods for assessing course learning outcomes using this assessment method, but they have not presented how course assessment can be used to assess program outcomes. Also, they focused on the improvement of courses through this assessment. Considering those issues, a basic procedure of course-embedded assessment which we have experienced in applying it is as follows. This procedure is not derived from our study and described in the literature[8] , but our experiences are added in this study.

Table 1 course mapping table

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.	Can evaluate design constraints according to business and technical requirements and create alternatives	50% of students will score 70 or higher on 'project design document'	Program outcome (3)
	Tool use	(2) to implement software component using appropriate tool	Can build efficient software component source code	50% of students will score 70 or higher on source code quality	Program outcome (5)

1. Selection of courses. As there are one or more courses, the identification of which courses would be assessed was 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 as the course for applying 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

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needs within realistic constraints. To select the course, a course mapping table like table 1 showing course outcomes mapped onto program outcomes was used and this information was extracted from the course syllabus[9].

2. Assessment tool for each course learning outcome. In order for one to evaluate the extent to which course learning outcomes have been attained, 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 method of how to relate achievement of course learning outcome with assignment of course grade as suggested in has not been considered in this paper yet.

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 would be 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 design 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.

Assessment results for two years from 2008 to 2009 indicated two analysis results; One thing is that a method for creating alternative designs according to the change of design constraints and requirements need to be improved. Also, an implementation strategy which reflects design constraints should be devised. These results show similar results as shown in the right bars in Figure 1 so that we can use course embedded assessment as a milestone for reviewing program outcomes.

IV. Conclusions

The objective of assessing course learning outcomes is to improve lacks of course outcomes, teaching method to help students 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 to assess program outcomes because of many factors occurred during the assessment. As program outcomes can be fostered throughout curriculum and each course may be related with one or more program outcomes, it is desirable to find a way to use course learning outcomes to assess program outcomes. Also, a method to review the extent which program outcomes are achieved through courses at specific point as a milestone before graduation is needed. To use course outcomes for the program outcomes assessment, these courses have to equip necessary conditions to assess program outcomes. One method for doing this is to use course embedded assessment technique. The contribution of this paper is to suggest two things. Using course outcomes except capstone courses is not proved to be an adequate method for assessing program outcomes, but we reviewed how the procedure of course embedded assessment can be applied and what issues should be considered to apply this method to program outcome assessment. In addition to this, we suggested new ways of using this method as a means of checking intermediate achievement level of program outcomes. If we can find lacks of outcome at earlier time, we can prepare a proactive improvement plan based on the assessment results.

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