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A Team Project Based Assessment Method for Engineering Design Course

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Abstract

Implementing prototypes and engineering design education that requires creativity among engineering students has become a universal trend. Engineering design education is a subject taught in a setting where students gather in a team, decide on a single topic, and cooperate with one another to perform a project. Team project based evaluation is a main part of engineering design education. Many instructors agree that harmonizing creative evaluation and outcome assessment is difficult. To resolve this issue, we have surveyed various creativity assessments and engineering design education methodologies, and have modelled existing evaluating elements into a creative process and outcome assessment framework for each team project assessment. We have evaluated students in three levels (fair, good, and excellent) for each assessment element. Based on the survey results from students who took the course, we concluded that the new assessment model is an innovative method of assessment that enhanced both the students' and the instructor's satisfaction of the course.

Keywords*: engineering design education, creativity assessment, outcome assessment, team project evaluation*

1. Introduction

Education in computer science and engineering is shifting from desktop computers to mobile devices, lectures to projects, and individual learning to collective learning. This trend is a direct result of the advent of ubiquitous computing technology which has allowed an individual to possess more than one device [1]. For example, Apple Inc. put the invention of innovative products-such as GUI and mouse based Macintosh computers, touch interface operated iPhones, and first computer graphic animation Toy Story on the market. An innovative CEO, Steve Jobs had ability to combine available technologies together and his brilliant business mindset. The importance of team project based engineering design course is also becoming emphasized in engineering departments in universities.

In South Korea, the Federation of Korean Industries has been investigating 'What Industries Look for in a University Curriculum' since 2003. After surveying approximately 200 CEO's from various industries, they found out that problem solving, human relations, basics of business administration, leadership are the common skills that business corporations look for when hiring. Meanwhile, the ABBEK (Accreditation Board for Engineering Education in Korea) introduced the concept of creative design in engineering education. ABEEK is a similar organization to ABET (Accreditation Board for Engineering and Technology) in U.S. and Engineers Canada in Canada. Two major programs, Computer Engineering and Information Engineering in Division of Computer and Information Technology at Daegu University, have achieved an accreditation from the ABEEK since 2009. Introduction to engineering design course for freshmen students and capstone design course for senior students were created in Division of Computer and

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Information Technology where the author works. These two courses decide students' grade solely based on assignments and team projects.

Encouraging students to think in an innovative way and to develop new products or new technologies is an essential component of applied science and engineering. An important aspect in innovative thinking is creativity. Leadership is defined as the process of social influence in which an individual can get the aid and the support of others to achieve a common goal. Since leadership acts as a base in the cooperation of a company or an organization, leadership development course is included in an engineering design course. Teamwork is an action performed by a team towards a common goal. We need to foster team members to work together to achieve a project goal in an engineering design course. These three issues – fostering creativity, developing leadership, and stimulating team activity – are important aspects for educators teaching a team based engineering design course. Thus the author has an interest on creative engineering design course development.

During my Sabbatical year at the School of Computing Science in Simon Fraser University, I investigated the assessment method involving both creativity and project outcome, *i.e.*, prototype or product in an engineering design course. After researching related works, we came up with an original process and outcome based assessment method to evaluate team project based engineering design courses. To support this concept, we have also proposed a course evaluation rubric consisting of three levels - fair, good, and excellent. This evaluation method has been proven to be effective according to student surveys.

This paper is organized as follows: Section 2 describes related works and the process and outcome based assessment method is proposed in Section 3. In Section 4, the rubrics with three depths for team project based engineering design course is represented. Section 5 specifically explains the course structure during a term. Section 6 demonstrates that the proposed teaching and assessment method is effective through questionnaire analysis of class students. Finally Section 7 sums up the paper to provide a conclusion for this work.

2. Related Works

We are interested in the fair evaluation of engineering design education reflecting creativity assessment methods. Some related works on creativity assessment and engineering design education have been surveyed as following.

2.1. Creativity Assessment

Creativity is a phenomenon whereby something new and valuable such as an idea, a solution, or an invention is created. The potential for fostering creativity through education and the measure assessing creativity in a class is particularly important. There have been many works striving to assess creativity for K-12 students and college students.

Cognitive scientists have defined creativity as a skill that encompasses fluency or quantity (= number of ideas), flexibility or variety (= number of different kinds of ideas), and novelty or originality (= number of new ideas). Purzer *et al*. defined engineering design creativity and developed an assessment tool to measure the creativity of 4^{th} and 5^{th} grade students' design ideas in an egg packaging project [2]. It suggested an example to define the idea's score with the products of novelty, feasibility, and viability in terms of engineering design creativity. Redelinghuys and Bahill utilized resources, efforts, and value to define several formulas for the assessment of the creativity of either individuals or teams cooperating in the development of new products to develop a generic approach for the measurement of technological creativity [3]. Jennings *et al*. described a computerized aesthetic composition task that is based on a "creativity as search" metaphor [4]. They modelled the creative process from a given problem to come up with a possible solution with two search strategies of interpretation strategy - how people translate goals into criteria and exploration strategy - how people move through the search landscape. Creative Engineering Design Assessment (CEDA), a useful tool that can effectively assess creative engineering design at the university level in engineering education, has been proposed by Charyton. Traditional divergent measures such as Owens Creativity Test and Purdue Creativity Test only measure engineering creativity by assessing fluency and flexibility, while CEDA measures both convergent thinking, which generates a solution to the given problem and divergent thinking, which generates multiple solutions to problems [5]. Instructors also successfully evaluated student's creativity with fluency, flexibility, and originality as well as usefulness [5]. These methods suggest many different ways to evaluate creativity, yet seem to lack the ability to be applied into the engineering design education curriculum.

2.2. Engineering Design Education

An attempt has been made to provide a comprehensive list of technical and non-technical skills for design engineers including analytical, open-ended problem solving, team communication skills, and modern tool skills [6]. The attributes of a design engineer are difficult to measure and will require the development of special rubrics. Every instructor wants know how to evaluate whether a design or other artificial creature is creative. There are few approaches that seek to evaluate creativity computationally. Among them, novelty, value, and surprise factors are used as a set of necessary conditions when identifying creative designs. Maher *et al*. have used computational models such as K-means clustering algorithm to compare a new design to existing designs and linear regression algorithms in order to identify outliers and find a trendsetter [7]. Most educators have added a common ideation approach called brainstorming to their engineering design curricula, but brainstorming requires designers to look inward for inspiration. Ogot *et al*. presented their experiences with introducing one of systematic creativity methods, the theory of inventive problem solving (TRIZ) [8]. TRIZ is "a problem-solving, analysis and forecasting tool derived from the study of patterns of invention in the global patent literature" developed by Russian G. Altshuller. They showed that TRIZ made it easier for students to generate feasible concepts to design problems from the comparison between TRIZ educated group and TRIZ non-educated group.

It is very difficult for the students to perform well on design engineering projects and for the instructor to assess student project work in a fair manner. Platanitis *et al*. developed rubrics to evaluate students' level of knowledge application for the three core design courses (1st-3rd year) and the capstone design course (4th year) [9]. This was developed based on a methodical tool useful in such evaluation called the ICE (Ideas, Connections, and Extensions) philosophy, to evaluate the extent to which students have applied their knowledge for various engineering design projects. Each component of ICE represents a level of application; Ideas showing the basic understanding of a concept, Connections representing the ability of one to relate knowledge and articulate relationships among the fundamental elements, and Extensions demonstrating the ability of one to take knowledge and to apply it to a novel situation [10]. The obtained results indicated comprehensive rubrics, which could be used as roadmaps for evaluating engineering design project courses. Current researches done on engineering design curriculum fail to connect the project's design process and its outcome assessment.

3. Process and Outcome Based Assessment

From the previous related works described in Section 2, we have realized the importance of many creativity assessment elements. A creative process can be considered in the path from a problem to a solution in engineering design education. These creative elements are put into three stages including brainstorming, building, and demonstration phases. We have analyzed these creative elements and rearranged them into the creative process of a team project. Novelty, fluency, variety, and feasibility are required for the brainstorming phase; resources, efforts, and viability/cost are needed for the building phase; and value, usefulness, and design are necessary for demonstration phase [11]. The ten creativity elements have been modelled in a creative process and outcome assessment framework called CPOA framework as shown in Figure 1.

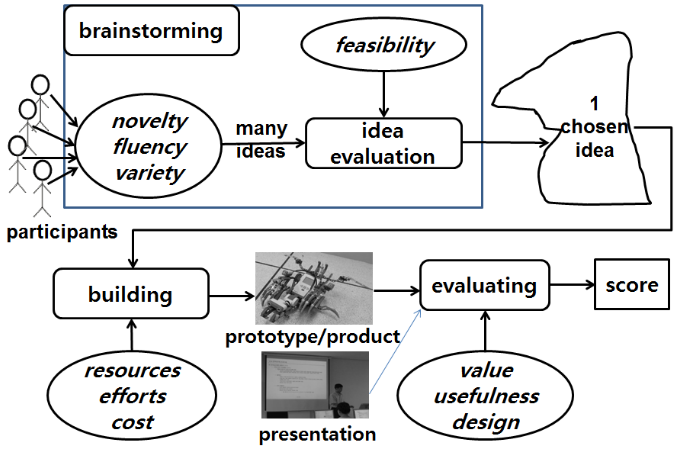

Figure 1. Creative Process and Outcome Assessment Framework in Engineering Design Course (The 10 Creativity Elements are in Ellipses, written in Italics)

A typical engineering design project consists of 3 to 5 students in a team. Team members brainstorm to find as many possible ideas they could come up with and evaluate the feasibility of selected ideas. With the chosen ideas, students build prototypes or products considering resources, efforts, and cost in the case of hardware project and development tools and efforts in the case of software project. During the demonstration process, students present their works. An instructor evaluates the project based on its value, usefulness, and design. Their score is determined not only by the creativity process assessment in the brainstorming and building phase but also by the outcome assessment in the demonstration phase. Final presentation is included in the assessment. When a problem happens in the above framework, feedback to the previous stage is given. Peer evaluation by student is also conducted to assess other team's work.

Table 1, 2, and 3 show the assessment traits and decision criteria in three phases respectively. For example, Novelty elements has three primary traits - difference, keywords, and comparison to previous works - in which each trait is measured either by student notes such as logbook (LB) or workbook (WB), or mostly by instructors, and sometimes by a student. The quality of each trait is decided by either process or outcome according to the trait [11].

Table 1. Assessment Traits and Decision Criteria in the Brainstorming Phase

Evaluating Elements	Primary Traits	Measuring Tool	Decision Criterion
Novelty	Difference	LB/WB	Process
	Keywords	LB/WB	Process
	Comparison to previous works	Instructor	Outcome
Fluency	Idea generation	LB/WB	Process

	Elimination of unnecessary ideas	LB/WB	Process
Variety	Divergence of ideas	LB/WB	Process
	Categorization	LB/WB	Process
Feasibility	Possibility	LB/WB	Process
	Effectiveness	LB/WB	Process
	Sketch	LB/WB	Process

Table 2. Assessment Traits and Decision Criteria in the Building Phase

Evaluating Elements	Primary Traits	Measuring Tool	Decision Criterion
Resources	Materials	LB/WB	Outcome
	External info/help	LB/WB	Process
Efforts	Workload distribution	LB/WB	Process
	Planning	LB/WB	Process
Cost	Budget	LB/WB	Outcome

Table 3. Assessment Traits and Decision Criteria in the Demonstration Phase

Evaluating Elements	Primary Traits	Measuring Tool	Decision Criterion
Value	Title	Instructor	Outcome
	Contribution	Instructor	Outcome
Usefulness	Operation	Instructor	Outcome
	Practicality	Instructor	Outcome
Design	Aesthetics	Instructor	Outcome
	Function	Instructor	Outcome
Presentation	Content, Attitude, Delivery	Instructor	Outcome
Peer evaluation	Idea, Design, Completeness	Student	Outcome
Overall success	Subjective evaluation	Instructor	Process/Outcome

4. Inspired Rubrics from ICE Approach

Every subject requires a fair grading policy to assess its course work. Midterm and final exams as well as assignments are general measurements taken to achieve this goal. However, some engineering design courses have no written exams. Instead, the courses are evaluated solely based on the student's team project activity scores. Thus, an effective assessment method to evaluate team project based engineering design courses should implement a fair team grading policy. Every instructor has his or her own marking criteria and standards. However, many of the grading tend to be very subjective because the rubrics are unclear. Having clear and descriptive rubrics allows instructors to make the evaluation process consistent and fair, demonstrate their expectations from the students taking the course, and help team teachers or teaching assistants grade student works in a consistent manner [12]. A method called Primary Trait Analysis (PTA) could be used to assess student performances or the portfolio of student performances that includes written, oral, assembled, and fabricated work. Walvoord *et al*. demonstrated how teachers could use PTA inside their course to make criteria and standards clear to themselves and to their students [12].

Ten creative elements derived from the analysis of previous works are transformed into primary traits for team project engineering design course. Novelty element is composed of three traits; difference, keywords, and comparison to previous works. Each trait has three level descriptive statements called rubrics. Each rubric is inspired from the ICE approach. According to this criterion, the first trait, difference has “enumerate existing ideas” is considered fair (Ideas level), “converge existing ideas” is considered good (Connections level), and “make an innovative idea” is considered excellent (Extensions level). The second trait states that keywords have “select simple keywords given in the project title” in the fair level, “use keywords including constraints given in the problem” in the good level, and “apply keywords considering problem solving strategy” in the excellent level. Third trait involves comparing previous works through search engines such as Google or Bing. Hence, “search previous works” is in the fair level, “search previous works and compare ideas” is in the good level, and “search previous works and present idea’s novelty” is in the excellent level. Fluency element is composed of two traits: idea generation and elimination of unnecessary ideas. Each trait has three level rubrics as shown in Table 4. Other eight evaluating elements such as variety, feasibility, resources, efforts, cost, value, usefulness, and design also have rubrics assigned in three levels.

Table 4. Primary Traits and Three Level Rubrics for Fluency Element

Primary Traits	Ideas (Fair)	Connections (Good)	Extensions (Excellent)
Idea generation	Just recall ideas	Analyze recalled ideas to associate or hitchhike them	Synthesize drawn ideas to generate new ones
Elimination of unnecessary ideas	Eliminate ideas without criteria	Compare ideas and eliminate redundant ones	Evaluate ideas and remove low valued ones

On the other hand, three additional evaluating elements such as presentation, peer evaluation, and overall success by subjective evaluation are proposed to assess the team’s cooperative work. The presentation element considers presentation content, presenting attitude, and delivery capability. Therefore, as part of presentational skills, “summarize activity, avoid eye contact, and give unclear presentation” is in the fair level, “summarize activity, keep eye contact, and deliver contents well” is in the good level, and “summarize activity, keep eye contact, articulate opinions, and lead to audience’s questions” is in the excellent level. Peer evaluation element has idea, design, and completeness as its trait. Finally overall success has each instructor’s subjective evaluation as its trait.

5. Course Structure

Capstone design course is an engineering design class that opens in the first semester for 4th year students. In the first three weeks of class, students learn about the theory behind capstone design process and are introduced to the grading criteria of the course. In the very first week, every student registered in the course writes a 12 week team project proposal in 1-2 pages (A4) length and submits them to the professor. The best 25% of the proposals are selected by the professor based on their excellence. The remaining 75% of the students join the selected 25% of the students voluntarily to form a team of four. A 12 week team project will be divided into half (6 weeks). Students will give out two presentations; one after 6 weeks, and the final presentation after 12 weeks.

For 5 weeks from week 4 to 8, students brainstorm together by performing each of their assigned tasks within their team. Additionally, they meet up with the professor once a week for help and assistance on the project. Here, students are required to hand in their individual progress reports along with the team workbooks. The professor will then examine the progress of the project by reading each team workbook during his or her weekly appointment with the students. Individual progress reports will be used to assess each individual separately after weekly appointment with each team is over.

In the beginning of the course, team workbook and individual report guideline were given to the students as a guide to help the students distinguish between team workbook and individual progress report.

Team workbook guideline: It is a report outlining the purpose and the direction of progress of the project written collaboratively as a team by based on the each of the team member's individual progress reports. When a team member is absent from his/her last team meeting, he/she can catch up with the project progress from the workbook during his/her absence. Each workbook should be submitted in 3 to 5 pages.

Individual progress report guideline: After everyone is assigned in their individual tasks during team meeting, each team member records his/her own work and role in the team for a week on their individual progress report. The length of the report should be written in maximum 2 pages in length.

By week 9, every team must present the progress of their project and what they expect to achieve from the project to the entire class. Professor will assess the progress of the team project based on the rubrics given in Section 4.

From week 10 to 14, students will fulfill the project based on their team workbooks and prepare a demo. Once in a week appointment with the professor to check up on the project will continue through these weeks. On week 15, final presentation of the project will occur and everyone must attend and present their project in teams and demonstrate the outcome of the project. The same examination process will occur for the final presentation as did for mid-presentation in week 9.

During the author's capstone design course in 2014 spring semester, 9 team projects were developed. We will show one example prototype among them where people with a hand disability or people with no access to the internet can use the voice control app in smartphones to control the computer. This process is so called, "PC voice control for people with disabilities". The team consists of four students. After brainstorming, the team members decided to carry out smartphone operation, Google's Text To Speech usage, communication system building, and so on. After receiving a voice command from the smartphone, communication, opening the web, opening folders and files, moving the cursor and scroll bars, enlarging and reducing images were to be supported. Figure 2 shows the progression of the project in a storyboard format [13]. In [1], an error reducing educational approach that incorporates role-changing brainstorming techniques in HCI design exploration process was proposed. Especially, the possibility of this approach through a term project within the capstone design course was illustrated and each team project outcome was evaluated based on this research.

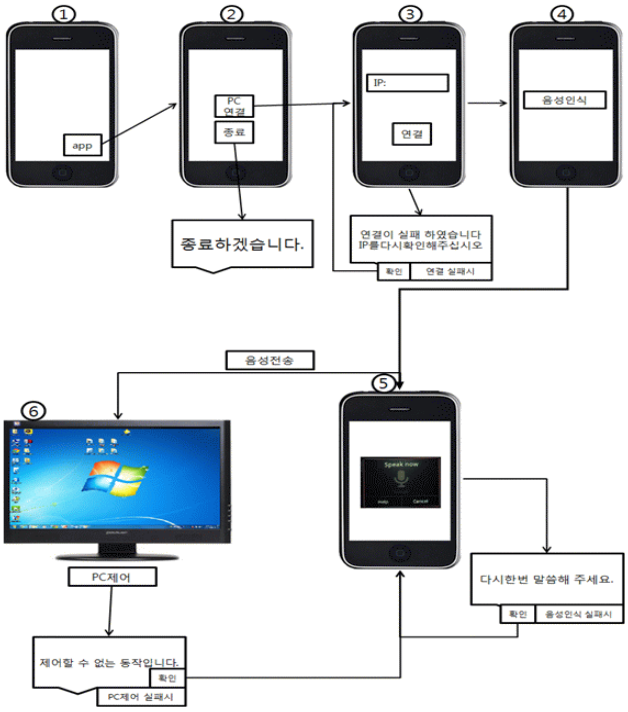

Figure 2. Storyboard Determined by Brainstorming within HCI Design Process

6. Class Survey and Statistical Analysis

After the final presentation, all of the 32 students taking the course took a survey. Table 5 shows the mean and the standard deviation of the survey questions. Each answer has 5 scales such as 1(= Strongly Disagree), 2(= Disagree), 3(= Neutral), 4(= Agree), and 5(= Strongly Agree). The reliability of the survey questions was verified using Cronbach's alpha coefficient, which is a tool to measure the internal consistency [14]. Out of the 10 questions asked, the first 9 questions had a degree of reliability being 0.89. The 0.89 value shows that students had a similar opinion, provided the high degree of reliability. Question 10 was excluded because it asks for improvements for a class composed of short subjective comments and opinions.

Table 5. Statistics for the Survey Taken After Final Presentation

Question items	Avg.	Std.
1. Do you think capstone design course progressed as planned?	3.84	0.677
2. Was phased project progression method (brainstorming, development, demo presentation) appropriate?	4.09	0.777
3. Was the development and production rating scale (resource, effort, cost) appropriate?	3.38	0.907

4. Was demo presentation rating scale (value, usefulness, design, presentation, peer evaluation) appropriate?	3.81	0.738
5. Was current approach which individual evaluation based on attendance and individual progress reports, team evaluation based on mid-presentation and final presentation ideal?	3.78	1.157
6. Do you think it is appropriate to strengthen individual evaluation including the use of individual progress reports?	3.28	1.198
7. Do you think it is appropriate to strengthen team evaluation including team workbooks and team presentations?	3.91	0.893
8. Do you believe that what you have learned in the class will be helpful in pursuing a career in future fieldwork?	4.22	0.906
9. Do you believe that the content of the class will be helpful in team project activities while pursuing a career in engineering fieldwork?	4.22	0.751

Question 2, or the appropriateness of phase-wise project progression method, and Question 8 and 9, or the helpfulness of the course in future projects, had average scores higher than 4, hence indicating that most students were very positive about what the questions were asking for. Excluding Questions 3 and 6, the averages of other questions are over 3.5, which indicate that the course had been a positive experience for most students. One reason why Question 3 has a low mean average value is because the level of difficulty of the project in the development process has not been accounted for in the evaluation of the development process. This was confirmed in Question 10, where the students were asked to write down their opinions. Another reason for this could be that most teams performed tasks focused on software building. The assessment criteria focused on the effort that the students put towards the project, but not much on the resource and the cost of the project. Hence, the insufficient focus on the assessment on the development's longest phase, or the building phase, could have perhaps caused Question 3 to have a low mean average value. The reason behind Question 6 having the lowest mean average could also be that students preferred to be assessed mainly on the group portion of the project, as opposed to the individual portion of the project. To avoid the students' tendency of refusing to complete individual progress reports, the importance of writing individual progress reports regularly while keeping up with their group work must be emphasized. Each of the team members will bring their weekly individual progress reports to team meetings and compare the tasks they have completed. In the meeting, the members will then collaboratively put together their individual progress reports to write a team project report. This approach of writing a team project report based on individual progress reports would improve the quality of team project report, as each of the individuals' tasks will be reflected onto the report.

In addition, Question 5 and 6 which asked for the appropriateness of individual evaluation had a standard deviation of approximately 1.2, which is about 0.25~0.5 higher than other questions. This shows that there were some discrepancies in the answers of the students for individual evaluation.

Lastly, further comments and opinions regarding the improvement of future classes have been collected. Some people enjoyed working as a team in completing a term project. Others said the project was completed successfully by effectively cooperating with other team members. Another student pointed out that team-based capstone design class has helped him or her understand the importance of communication within the team members. There were also contrasting opinions where some students said team workbooks should replace individual progress reports, whereas others said individual progress reports were troublesome to do at first but at the end helped organize weekly progress to write team workbooks. There were also other opinions given. Some said having an adequate number of team members and the team formed by students studying different majors enhanced the level of difficulty of the project, while others said more time should be given to prepare for the projects and evaluation should also include the difficulty level of development methods.

According to the results of the survey, the suggested CPOA framework based assessment model showcases an example of assessing a capstone design course with a focus in two different criteria: creativity and outcome. The new model has an individual component to the original assessment method, which was based solely on team reports and team meetings. The new model puts an emphasis on the use of individual progress reports to take each of the team member's individual efforts into account and prevents individuals from getting a biased mark based on the quality of their group members. Although this new assessment model requires more effort and time, it is a more objective method of assessment that increased the satisfaction rate of course for the professor as well as the students taking the course.

7. Conclusion

In this research, we presented a new team project based assessment method, Creative Process and Outcome Assessment (CPOA), for creative engineering design course. There are many related works to the subject. However, this work has several features that distinguish itself other than the previous works. By identifying the ten creativity assessment elements from surveying many related works, we categorized them into three phases based on the project's progression to propose a new assessment framework called CPOA. This framework has special feature considering not only the outcome assessment of the project but also the assessment of creative process. Then we derived the primary traits from each assessment element and categorized them into three level rubrics: fair, good, and excellent. Lastly, the proposed assessment method was implemented into a capstone design course for senior students and the effectiveness of the method was surveyed after final presentation. The survey analysis suggested that the proposed method of teaching process helps enhance students' designing process. Students also believed that current class grading scale was appropriate. It also suggested that the class has been beneficial to students as they will have experienced working cooperatively in a team. Heretofore, teams were simply assessed by the concreteness of their weekly reports, the creativity presented in their topics in their mid-presentation, and the completion of their project in their final presentation. Recognizing the lack of creativity and thoroughness of the assessment method of team projects, we improved the assessment method to more thoroughly and objectively evaluate students.

In the future, there is a need to fix the evaluation section of team project based assessment method in accordance with the specifics of hardware projects or software projects and subject specificity. Also, there is a need to cooperate with other research instructors who teach similar courses and to apply the proposed team project based assessment principle to different subjects to universalize team project based education.

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References

[1] J. Kim, "Exception Handling Education Approach Incorporating Role-Changing Brainstorming Technique in HCI Design Process", International Journal of Multimedia and Ubiquitous Engineering, vol. 9, no. 6, **(2014)**, pp. 159-170.

[2] S. Purzer, W. P. Myers, D. D. Wiles and J. Strobel, "Assessing engineering design creativity in K-12 student designs: exploring an egg packaging and drop activity", 2nd P-12 Engineering and Design Education Research Summit, Washington DC, **(2012)**.

[3] C. Redelinghuys and A. T. Bahill, "A framework for the assessment of the creativity of product design teams", Journal of Engineering Design, vol. 17, no. 2, **(2006)**, pp. 121-141.

[4] K. E. Jennings, D. K. Simonton and S. E. Palmer, "Understanding exploratory creativity in a visual domain", Proceeding of the seventh ACM conference on Creativity and Cognition, Atlanta, **(2011)**, pp. 223-232.

[5] C. Charyton and J. A. Merrill, "Assessing general creativity and creative engineering design in first year engineering students", Journal of Engineering Education, vol. 98, no. 2, **(2009)**, pp. 145-156.

[6] N. Mourtous, "Defining, teaching, and assessing engineering design skills", Int'l Journal for Quality Assurance in Engineering and Technology Education, vol. 2, no. 1, **(2012)**, pp. 14-30.

[7] M. L. Maher, K. Brady, and D. H. Fisher, "Computational models of surprise in evaluating creative design", Proceeding of the Fourth Int'l Conf. on Computational Creativity, Sydney, Australia, **(2013)**, pp. 147-151.

[8] M. Ogot and G. E. Okudan, "Integrating systematic creativity into first-year engineering design curriculum", Int'l Journal of Engineering Education, vol. 22, no. 1, **(2000)**, pp. 109-115.

[9] G. Platanitis and R. P. Iliev, "Establishing fair objectives and grading criteria for undergraduate design engineering project work: an ongoing experiment", Int'l Journal of Research and Reviews in Applied Sciences, vol. 5, no. 3, **(2010)**, pp. 271-288.

[10] S. F. Young and R. J. Wilson, "Assessment and Learning: The ICE Approach", Portage & Main Press, Winnipeg, **(2000)**.

[11] J. Kim, "An assessment method to evaluate team project based engineering design", Proceeding of Int'l Conference on Computer Science & Education, Vancouver, Canada, **(2014)**, pp. 257-260.

[12] B. E. Walvoord and V. J. Anderson, "Effective Grading: A Tool for Learning and Assessment", Jossey-Bass Inc., San Francisco, **(1998)**.

[13] J. Kim, "New HCI Design Process Education", Proceeding of ICECCE 2015, Marrakech, Morocco, **(2015)**, pp. 2002-2005.

[14] L. Cronbach, "Coefficient alpha and the internal structure of tests", Psychometrika, vol. 16, no. 3, **(1951)**, pp. 297-334.

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