Implementation of Online Peer Assessment in a Design for Learning and Portfolio (D4L+P) Program to Help Students Complete Science Projects

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ABSTRACT
Peer assessment was one of the most effective strategies to improve students' understanding, metacognitive skills, and social interaction. An online tool, *Designing for Learning and Portfolio (D4L+P)*, was developed solely to support the T5 (tasks, tools, tutorials, topicresources, and teamwork) method of teaching and learning. This research used the D4L+P program ina project-based learning (PBL) approach and developed a marking scheme rubric as a topic resource in a task to improve peers' abilities as assessors. The objectives of this research were to compare the points offered for effort to plan proposals for science projects and the points offered for effort to give feedback, and also to analyze students' reflections as evaluators of the science projects using the D4L+P program compared to the reflections of teachers and experts in PBL. The participants were twenty-five grade 10 students aged 15 and 16 in a science enrichment program, 15 teachers, and five experts Findings showed that 94% of students preferred giving suggestive feedback about doing science projects. Results also indicated that the students and the experts had similar patterns of giving feedback (suggestive-corrective-reinforcing) while the teachers' patterns emphasized reinforcing feedback. The researchers regard the use of the D4L+P program with the marking scheme rubric in a PBL approach as an alternative learning strategy that requires students to practice the giving of suggestive feedback online.

Keywords: online peer assessment; D4L+P program; project-based learning; science project

INTRODUCTION
A number of researchers (Tsivitanidou, 2016; Liu, 2013; Freeman, 2002) found that web-based peer reviewswere an effective instructional strategy and innovative assessment method to encourage students to be constructive and focus on the improvement of thequality of their work. Peer interaction constructs conflictedwith their existing knowledge and resulted in disequilibrium. However, through dialogues, questions, and discussions with peers, a new equilibrium with higher understanding (Piaget, 1959, cited in Fawcett & Garton 2005) and cognitive development of the learners (Vygotsky, 1978) was reconstructed. Peer assessment was a process in which students or their peers graded assignments based on teachers' criteria (Sadler, Good, 2006; Tenorio, 2016a). This practice improved their understanding, social interaction (Sobhanian, 2016), and metacognitive skills (Yusuff, 2015).

In the performance of science projects, it was found that students lacked skills in the setting of research questions (Wuttiprom et al, 2016) and peer assessment (Ballantyne, 2002; Ng, 2016), and Wong et al. (2016) stated that students preferred online and teacher assessment. Tenorio et al. (2016b)revealed that the provision of points and medals by teachers encouraged students to participate more frequently in peer assessment, and support guidelines were essential to develop good feedback skills.Kritikos et al. (2011)found that peer discussions in PBL tutorials provided opportunities for students to learn from peers and Hou et al. (2007)indicated thatin-depth considerations of peers' reports resulted in the improvement of the quality of projects.

A survey of the behaviour of internet users in 2015 showed that people aged between 15 and 34 years were thosewho accessed the internet the most, totalling eight hours per day. Also, 92.1% and 85% of them accessed

Facebook and Line respectively (Electronic Transactions Development Agency, 2015). Generally, these two programs were used to exchange opinions with family and friends, and for academic purposes (Kirschner and Karpinski, 2010). Facebook and Line programs are powerful tools of instructional design in the 21st century in terms of the enhancement oflearners' reflective skills. Reflection was a process of systematic consideration of knowledge or experiences to comprehend them to conceive how knowledge and experiences are meaningful and affect the individual and others. The process enhances the potential of learners to be skillful in the solution of complex problems or unpredictable situations (Mann et al., 2009). However, these programs have a limitation on systematic learner assessment.

In response to this situation, the researchers developed a learning management system based on Richards and Sophakan (2006)called the *Design for Learning and Portfolio (D4L+P)* and created a learning environment based on a co-operative learning approach called the T5 learning model which emphasized Tasks (learning tasks with deliverables and feedback), Tools (for students to produce the deliverables associated with the tasks, which was D4L+P in this case), Tutorials (online support/feedback for the tasks integrated with the tasks), Topics (content resources to support the activities), and Teamwork (role definitions and online supports for collaborative work) (salter et al., 2004). Learning tasks require students to engage in the course content to produce a deliverable artifact. The deliverables and feedback to these deliverables were the primary vehicles for learning. The relations among these components are illustrated in Figure 1.

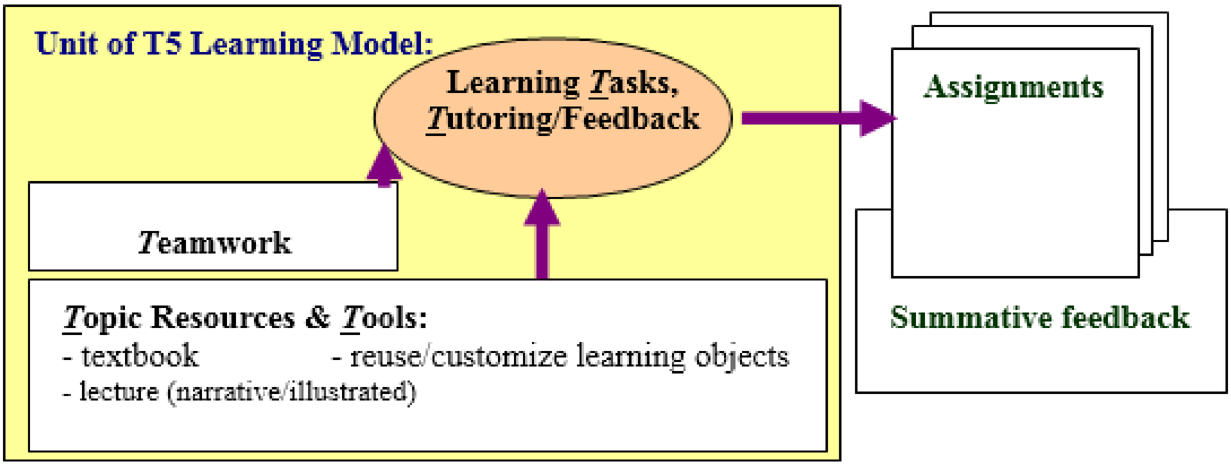

Figure 1: Unit of T5 learning model (Buzza et al., 2005)

This program was incorporated in a project-based learning approach in an 'information management' subject and it made use of coding to classify online discussion content into groups.

The tutorials part was the instructional design for adults (andragogy) (Cross, 1981) which strengthened students' fundamentals to complete science projects equivalent to university students' research, and encouraged active learning and social constructionism. Research revealed that the application of the D4L+P program efficiently increased conceptual understanding (Wuttiprom and Chaiwatthana, 2014), learning achievement (Supasorn, 2014), and the positive attitude of learners towards instructional design (Wuttisela, 2014). The researchers agreed that the main reason for the use of the D4L+P program was the increased peer collaboration and discussion and fewer overdue assignments. It also recorded the history of feedback, similar to WIDE (Hou, Chang, and Sung, 2007), a program called*web-based instructional design environment*that contained a feature by which students were able to give feedback online.

However, there was a lack of research that links D4L+P to PBL, an instructional design that creates a new learning skill for the 21st century in which communicating, co-operating, finding and evaluating information, creating and innovating, problem-solving, and analytical thinking are required. To address this lack of research, this study applied the D4L+P program to PBL instructional design in science.

OBJECTIVE

1. To compare points awarded for effort to plan science projects and points awarded for effort to give feedback
2. To analyze students' reflections on the D4L+P program as evaluators of science projects compared to the reflections of the teachers of the science projects and experts

METHOD

Participants

Data were collected from a group of 25 outstanding grade 10 students aged 15 and 16 in an enrichment science classroom program which focused on the development of creativity in research and science project management skills. Data were also collected from 15 teachers and 5 experts from a published article by two of the researchers of this study (Wuttiprom et al., 2014).

Procedures

The instructional activity of PBL in this research was designed to allow the students to take the roles of persons who gave feedback and assessed this feedback through the D4L+P program.
The steps in the procedure were:
1. Engagement in PBL instructional design. The sample group engaged in PBL instructional design with the teacher who taught science projects for three months.
2. Participation in a workshop. The sample group participated in a three hour workshop with the researcher on the principles of giving feedback for each part of a science project (Table 1). The researcher uploaded teaching material to the D4L+P program as a checklist as a guideline of project proposal assessment (Table 1). The teachers and experts gave feedback without a checklist.

Table 1: Guideline for feedback for each part of a project

Parts	Guideline for Suggestions
Title	□Title includes independent variable and dependent variable □Title is comprehensible and implies the content of the project
Background and significance	□The answer to the “Why” questions, such as why does pineapple shell accelerate the growth of plants?
Objective	□Each objective contains independent variable and dependent variable □The project has two parts, so that there are two objectives
Hypothesis	□Predict the answer with reasons connected to scientific theory
Independent variable	□The factor deliberately changed in an experiment □Identify the independent variable in all steps if there are many parts to the experiment □Identify the type or quantity, such as type of soil or quantity of soil □Be measurable by scientific tools
Dependent variable	□ The amount that results from the independent variables □Identify dependent variables in all steps if there are many parts to the experiment □Be measurable by scientific tools
Controlled variable	□Results will be erroneous without controlling this factor
Experiment design	□Has only one independent variable □Others can follow the instructions and get the same results □Identify quantity of solid as gram and mL for liquid □Identify the reasons why certain chemicals are required in each step □Establish that the experiment is reliable and valid □Continue Part 2 with the best experimental results of Part 1 □Establish that the experiment is reliably based on scientific principles

3. Writing of the project proposal. Each student wrote a project proposal on the designed form, the topic being based on individual interest.
4. Upload of the proposal. After the due date for proposal submissions, all students were required to upload the proposal file onto an online system (D4L+P). The system randomly shared proposal files and each student received three proposal files.
5. Students' reflection and evaluation. Each student gave feedback for the project proposals of the three files and assessed the project proposals based on Marking Scheme Rubric (Table 1). Points for effort were awarded (1 to 5) for completion of the proposals.
6. Completion of peer assessment. Each student read the feedback from the peers and assessed the students' reflections received from the peers. Points for effort were awarded to the peers giving feedback (1 to 5).
7. Group discussion and revision of project proposals completed. The students discussed and revised the project proposals based on the peers' feedback.
8. Completion of discussions with teacher. Teacher and students discussed interesting aspects.

All the steps had clear submission dates and times on the D4L+P system. Students who were overdue were not allowed to submit the tasks.

Data Analysis

The students' reflections were divided by two researchers into three categories: corrective feedback, reinforcing feedback, and suggestive feedback (Chi, 1996). The division into these categories by the two researchers (Tseng and Tsai, 2007) was found to be consistent at a rate of 80%. The students' inconsistent reflections were discussed again by the researchers and a consensus was reached.

FINDINGS AND DISCUSSION

Part 1 Comparison of points awarded for effort to plan a science project and points for effort to give feedback

In the D4L+P program, the students submitted proposals in Task 1 before the reviewer gave a score and comment. To minimize bias, multiple reviewers were used in a peer assessment process (Tseng and Tsai, 2007).The program sent a score and comment back to the reviewee without the name of the reviewer. Therefore, the D4L+P system required students to give and receive feedback with a blind review. The system not only gave feedback but also required the students to award points for effort to peers. Generally, students gave points for effort to do a science project in task 2 and gave feedback in task 3 at averages of 2.86 and 3.55 (Figure 2) out of 5 respectively. These indicated that students attempted to do proposals of science projects and gave feedback at moderate and high levels respectively. A possible reason for the points for effort to give feedback being higher than to do the proposals of science projects may be because this research promoted giving suggestive feedback based on the marking scheme rubric. This meant that the students had more guidelines for giving feedback on projects, similar to the online peer assessment task of Tseng and Tsai (2007).Wong (2016) agreed with this finding that the students still needed forms of assessment to improve their skills to develop expertise in the future.

In regard to the peer reviews, students read three peer proposals and the rubric and also gave scores and feedback. These were cognitive activities to improve the review process, the projects, the students' reading and writing skills, and the promotion of active student-centered learning. Further studies are required to investigate the quality of peer feedback and students' ability to write the final reports of science projects.

High scores in peer assessment revealed that the students preferred peer interaction. However, previous research REF? stated that students preferredpeer assessment and teacher assessment. This may be due to the fact thatteacher assessment may help students to gain more knowledge and provide better guidance.

Scores for the proposals of the science projects were lower. Freeman (2002) believed that such scores may be improved by students' self-assessment before submission of their work. Self-assessment with the marking scheme rubric similar to Task 2 may increase the scores and enhance the quality of the proposals.

Figure 2: Points for task 2 and task 3 in D4L+P program

Part 2 Analysis of students' reflections on the D4L+P program as evaluators of science projects compared to the teachers' and experts' reflections

The researchers classified the students' reflections as evaluators of science projects into three categories: 1) Corrective feedback – given when incorrect facts were stated – for example, information that the province of Ubon Ratchathaniplanted the most rice was incorrect and the year of reference was not identified; 2) Reinforcing feedback – given to encourage students' good work – for example, good content; 3) Suggestive feedback – given to make suggestions to students about incomplete information – for example, did you study the nutrients of the preserved ants' eggs?

Comparisons of the percentages of the feedback of the experts and teachers based on information from the research of Wuttiprom et al. (2014) and the percentages of the feedback of the students in this study are shown in Figure 3.

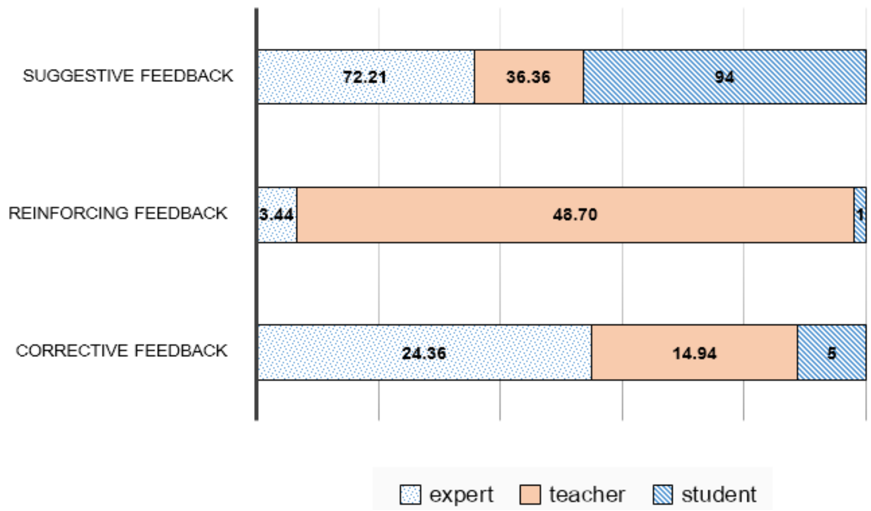

Figure 3: Bar chart displaying percentages of feedback of the teachers, experts, and students

Just under half (48.7%) of the teachers gave reinforcing feedback which helped improve students' projects more than corrective feedback (Tseng and Tsai, 2007). In contrast, only 3.44% of the experts' feedback was reinforcing and 72.21% was suggestive, while 94% of the students' feedback was suggestive (Figure 3).

Samples of students' feedback given for the project 'Ant egg preservation for out of season consumption' in the D4L+P program are shown in Figure 4. Most of students gave intensive, comprehensive, and systematic suggestions and followed the rubric.

These results showed that the researchers had provided guidelines for suggestive feedback in the topic resource and most experts also gave this type of feedback (Wuttiprom et al., 2014). The feedback was very useful for the students in the sample group of this research who had just started working on the first step of the projects (Tseng and Tsai, 2007).

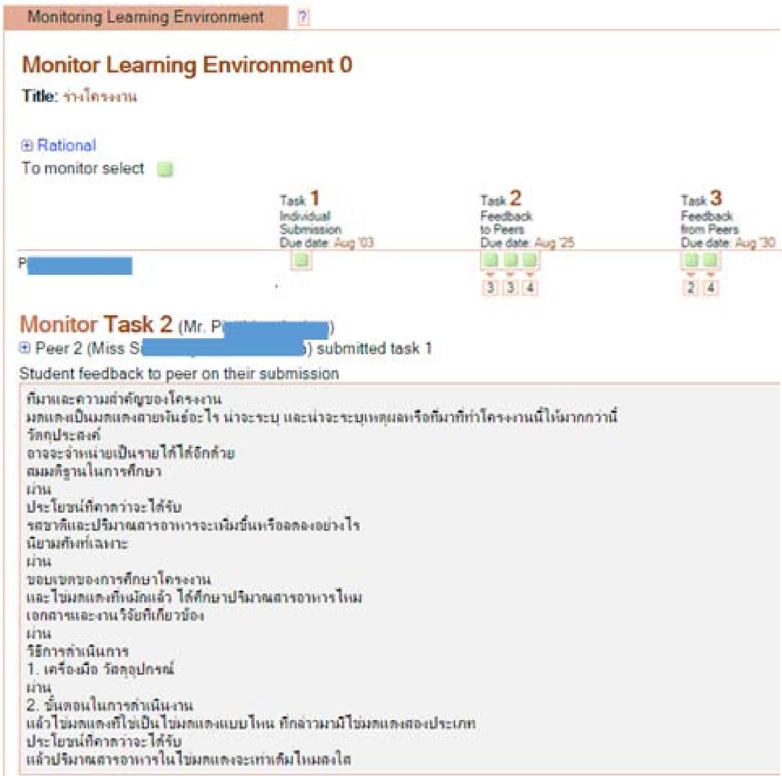

Figure 4: Feedback for Task 2 in D4L+P program for science projects

Cross (1981) stated that providingstudents with opportunities to offer feedback about science projects with the D4L+P program helped them to think as adults. It was found that 5% of students' feedback and 14.94% of teachers' feedback was corrective, which was less the 24.36% made by the experts. This was due to the students' and teachers' lack of experience and fundamental knowledge. However, the 94%of students who gave suggestive feedback was greater than the 72.21% and 36.36% of the experts and teachers respectively.

Advanced feedback might be generated in many ways to improve assessment (Liu, 2013). The marking scheme rubric of the peer assessment system in the D4L+P program decreases teachers' workloads(Rubin, R. F. & Turner, T., 2012) in the provision of suggestive feedback and promotion of skill in the delivery of good feedback.The program may help to solve problems of online peer assessment arising from students' lack of confidence in the performance of peer assessments (Ng, 2016).

The researchers state that the D4L+P program can be incorporated within the T5 learning model. It can also be integrated into the PBL approach when teachers ask their students to practice reflection or give feedback as it provides them with opportunities to criticize others' work and may help improve their own work. The D4L+P program may be an alternative for teachers who use other learning approaches but require students to practice giving feedback online, such as the use the D4L+P program for formative assessment by peers of students' plans or in presentation sessions in STEM education.

CONCLUSION AND FUTURE DIRECTIONS

This article reported the use of the D4L+P program to assist PBL instructional design to enhance academic social interactionin in regard to science projects. This was done by thecomparison of the points offered for effort to plan proposals for science projects and the points offered for effort to give feedback, and the analysis of students' reflections in relation to those of teachers and experts.The average scores for making an effort to give feedback and to plan science projects were 3.55 and 2.86 respectively. These scores indicated that the students attempted to give feedback and plan the science projects at high and moderate levels respectively. Data showed that they had confidence in the performance of peer assessments. As evaluators of the science projects, the percentages of students and experts who made reflections that were classified as suggestive feedback were greater than the percentage of teachers. The percentage of students who gave suggestive feedback was more than that of the experts but the percentage of students that gave corrective feedback was less. Results indicated that the marking scheme rubric incorporated with D4L+P program can decrease teachers' workloads in regard to giving suggestive feedback.

This study has a number of limitations. These include thesmall sample size and the problem of generalization of the use of themarking scheme rubric for feedback to other disciplines. In the future, the researchers intend to compare the science process skills of students who provide reinforcing feedback and suggestive feedback.Off-campus users who wish to use the D4L+P program in their classroom may contact the webmaster by e-mail. The program requires further development for use by e-mail, Facebook, or line to inform students of new tasks.

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