Student Voices Guiding Class Content in a PBL English Classroom

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At a national university in Japan, the authors developed a cross-department and team-taught project-based learning (PBL) English course. The participants were 2nd-year mechanical engineering and architecture students working in mixed discipline teams. Their goal was to complete various engineering projects while developing critical-thinking skills. The authors will briefly outline the course then describe the components of the research study focusing on (a) grounded theory principled analysis of class participants' 2014 qualitative data, (b) an explanation of how this analysis informed the classroom instructors to add a critical thinking activity in 2015, and (c) an analysis of participants' reactions to the critical thinking activity. Finally, the authors will discuss future directions for PBL instruction in an English language teaching context.

日本の国立大学で、筆者たちは複数学科混合でチーム指導型の英語の課題解決型学習（PBL）の授業を開発した。この授業では、建築と機械工学専攻の2年生の混合グループで、架橋モデル制作などの工学プロジェクトの完成を目指し、クリティカル・シンキング（批判的に考える）能力（critical thinking skills）の開発を目標にした。本論では、最初に当授業の課題解決型学習などの教授法の原理を説明する。そして、研究報告として：（1）2014年前期の初回の授業にて参加学生から収集したジャーナル及びアンケート形式データの、グランデット・セオリー・アプローチに基づく分析、（2）2015年後期に行った二回目の授業にて上記の分析がよりクリティカル・シンキングに焦点を当てた授業内容を発展させるうえで与えた影響についての説明、（3）その具体的な活動に対する参加者のフィードバックの分析について述べる。最後に、英語教育におけるPBL教授法の今後の方向性について考察する。

To prepare Japan for the 21st century, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) has designated project-based learning (PBL) as a vital element in reforming Japan's education system by 2030 (Suzuki, 2015). MEXT also highlights critical thinking skills as a requirement for success in a 21st century globalized world. These are long-term visions for Japanese education and society, which our research also embodies.

The authors designed a longitudinal research study that looked at the effects of English-language PBL on groups of engineering and architecture students at a national university in Japan by setting up a research structure that followed student participants of a PBL course. By the end of the research project, three iterations (PBL1, PBL2, and PBL3) of the PBL course were conducted with a total of 72 participants (24 participants per iteration). The authors collected qualitative data that included responses to open-ended questionnaires, personal reflections through student journals, and student interviews. For the purposes of this paper, the authors will focus on how the data collected from the students informed changes in the course that resulted in using a specific critical thinking activity—*Craggy Rock*—to assist the students in reaching their final project and course goals.

First, the theoretical framework will be outlined, providing the literature the authors reviewed to create the PBL English course. Second, the methodology will be explained, describing the study design and data gathering tools. Third, the authors will present the results of collected data from PBL1 then describe the critical thinking activity called *Craggy Rock*, which was developed for PBL2 based on data from PBL1. Fourth, results from data collected during PBL2 will also be presented affirming that changes made by the instructors were valid. Finally, the authors will outline future research areas and implications for PBL as a teaching method in an English as a foreign language classroom.

Theoretical Framework

The explanation of the theoretical framework has three sections—PBL, critical thinking, and course objectives.

Project-Based Learning

The inspiration for this class came from the desire to provide an environment where students could become communicatively competent professionals who could explore their knowledge and skills in order to contribute to Japan as a nation and as a member of the world of nations (Ravesteijn, De Graff, & Kroesen, 2006). Pedagogically, the intention for this PBL course was to ground it in a fundamental idea of PBL as an approach to teaching and learning. Table 1 displays our general understanding and stance of PBL. It includes literature about science, technology, engineering, and math (STEM) teaching and learning practices as well as more philosophical discussions.

Table 1. Elements of Project-Based Learning

Prince and Felder (2006)	Tyagi and Kannan (2013)	Mergendoller and Larmer (2015)
1. Teams of students 2. Open-ended assignments 3. Resembles professional life 4. Students formulate solution strategies 5. Measure approach against goal/result 6. Broad scope, several problems 7. End product is central 8. *Applying* integrated knowledge (<u>not</u> acquiring)	1. A need to know 2. A driving question 3. Student voice and choice 4. 21st century skills: collaboration, communication, critical thinking, and use of technology 5. Inquiry and innovation: new questions, testing ideas, and drawing own conclusions 6. Feedback and revision: performance 7. Publicly presented product: real audience	1. Challenging problem or question 2. Sustained inquiry 3. Authenticity 4. Student voice and choice 5. Reflection 6. Critique and revision 7. Public product 8. Key knowledge, understanding, and success skills

Prince and Felder's (2006) identified elements, which pertained to PBL and engineering students, reads like an instruction manual about necessary facilitator objectives to use when designing a PBL course. Tyagi and Kannan (2013) developed their list of elements within the paradigm of English for specific purposes (ESP), which related directly to the course referenced in this paper. Finally, Mergendoller and Larmer (2015) provided a list of project elements within an overall PBL framework. Elements 1 to 7 focused on the project types that facilitators and students would be working on; the eighth is the unifying vision.

PBL as a pedagogy has been around since at least John Dewey (Capraro, Capraro, & Morgan, 2013), so the stated literature is not exhaustive. However, these particular academics speak to the authors' message: PBL is more than just a way to set up a class. PBL is a guiding philosophy that informs not only the structure of the class but also the rationale for why the class exists.

Critical Thinking

The authors' intention was to design a course where critical thinking was obvious throughout. Ideally, students and instructors would look at any given task and realize they would have to think ahead of where we were, but "too many people, PBL practitioners and advocates alike, assume that PBL is synonymous with Critical Thinking. It's not" (Mergendoller, n.d., para. 9). It was not until later that we (the instructors) realized we had to do more due diligence regarding the critical thinking component of the class.

Mergendoller (n.d.) described critical thinking as "ordinary thinking done well, that is reflectively, with attention to criteria, and with the goal of making a defensible, reasoned judgment" (para. 4). Researchers from the University of Louisville (2016) stated, "The ability to think critically calls for a higher-order thinking than simply the ability to recall information" (para. 1). Lau and Chan (2016) defined critical thinking as "the ability to think clearly and rationally about what to do or what to believe" (para. 1). These definitions provided a base for our understanding of critical thinking.

Capraro, Capraro, and Morgan (2013), in writing specifically about STEM PBL, asserted that central to PBL was critical thinking. Their work accounts for the various lists of PBL elements and characteristics referenced earlier but also links them to critical thinking, a process that involves rigor and drive for greater understanding of real-world problems. Properly implemented, a PBL curriculum should provide a system that not only fosters critical thinking but is also driven by critical thinking (Capraro, et al., 2013).

Course Objectives

For this course, PBL was a foundational pedagogy. The instructors believed the students possessed critical thinking skills, but by utilizing a PBL approach, those skills could be further developed. To faithfully implement a PBL curriculum, critical thinking skills needed to be a stated primary objective.

The literature on PBL and critical thinking that informed our study's theoretical framework led to the following four class objectives—to improve engineering English, professional presentation, collaboration, and critical thinking skills.

Methodology

This was a qualitative study designed using elements of grounded theory and exploratory practice (for more on exploratory practice see Allwright, 2003; Hanks, 2015). Denzin and Lincoln (2005) purposed qualitative research methods as ones that "seek answers to questions that stress *how* social experience is created and given meaning" (p. 10). To align with that understanding required a great amount of input from the participants of this study, who were the students and instructors. The authors did not discount the importance of objectivity but for this study decided to develop an environment conducive to the blending of teaching, learning, and research (see Allwright, 2003). The following sections detail the data acquisition tools, coding structure, and provide support for the decision to use qualitative research methods.

Triangulation of Data

The authors used triangulation to obtain and synthesize multiple sets of data to clarify and enrich our report (Creswell & Clark, 2006; Wolcott, 1994). Collected data were derived from student *professional journals* and questionnaires. Professional journals were kept by both spring 2014 (PBL1) and fall 2015 (PBL2) course participants. The contents of the professional journals were freewriting entries and project diary worksheets adapted from one designed by Beckett and Slater (2005).

For freewriting, students were required to answer certain questions that varied every week. They also had to write their thoughts on anything involving the class. The project diary worksheet had prescribed sections for student participants to write comments about language used and skills learned over the previous week. Each participant was required to complete one every week and turn it into the instructors (the authors) for grading and comments. Grades were decided on a scale of 1 to 5 (low to high). Each instructor would grade the professional journals in isolation, then compare grades to come to a consensus.

The questionnaires for the 2014 course (hereinafter PBL1) included a general freewriting on the course. In July 2015, approximately one year after course completion, there was a follow-up questionnaire conducted. This questionnaire contained open-ended questions that asked participants about

- classes they had taken over the past year;
- how the participants felt the PBL course experience impacted their performance in those classes, if at all;
- how the participants felt the PBL course experience impacted their performance in life outside of classes, if at all; and
- what their future plans were.

The importance of gaining student feedback was a significant element of this course. However, response rates for the questionnaires varied. Initially, all 24 students responded. The second questionnaire had only eight students respond. There were multiple reasons for the varied response rates. First, there was an inability to contact some students using email and telephone. This suggested those particular students did not want to participate. Second, some students simply declined to participate further. No pressure or repercussions were placed on any student to participate. The parameters of the study were vetted on multiple levels including by requisite university officials.

Theoretical Coding

Due to the inductive nature and longitudinal aspects of the research, we believed a grounded theory method of theoretical coding would be the most effective approach. This allowed us to analyze data and develop and refine data collection methods as necessary (Prince & Felder, 2006; Thornberg & Charmaz, 2014).

We conducted line-by-line initial coding on all the data. There was a risk of researcher bias with determining codes, so we created codes independently and compared them against each other. Being collaborating researchers who co-taught the class was helpful in this manner because there was always someone familiar with the project to check the work of the other. Sometimes we maintained our individual interpretations, but other times we found consensus, the latter being the result of most cases.

To provide a concrete example: Student A from PBL1 wrote in a professional journal entry, "I read Global Wealth Databook 2013. Household income wealth data says that India is low income." We independently coded the entry *investigation* and *book research*.

After comparison and discussion of proposed independent codes, we agreed on the overarching code *research*. From this initial coding, themes emerged that allowed for insight into course improvement for the second iteration of the PBL course. We could also analyze the changes, specifically the critical thinking aspects associated with the activities interpreted through student responses.

Analysis of Data

We will describe the themes derived from collected data. These results allowed us to find and address areas that needed improvements in the overall scaffolding of course content towards a fully developed PBL project and compare how students' perceptions changed after implementation of these changes. The results also gave us insight into the development of critical thinking skills.

PBL1 December 2014 Questionnaire Results

A total of 24 participants from PBL1 completed this postcourse open-ended questionnaire. Certain themes emerged through the initial coding process. We divided themes into positive—the participants appeared to believe this was a positive aspect of the course—or negative—the participants appeared to believe this was a negative aspect of the course. Interpretations of whether an item was positive or negative were determined by the context of the answer. The numeric results are indicated in Table 2.

Table 2. Theoretical Coding Themes Mentioned by Three or More PBL1 Participants for December 2014 Questionnaire (*n* = 24)

Theoretical coding theme (positive (+)/negative (-))	Number of participants
Presentation (+)	14
Knowledge acquisition in other fields (+)	7
Research (+)	5
Design (+)	5
Time-consuming (-)	5
More TOEIC (-)	6
More English (-)	5
Burdensome (-)	4
New (+/-)	3
Anxious (-)	3

PBL1 July 2015 Questionnaire Results

Eight students completed this open-ended questionnaire. The objective was to assist the students in remembering the PBL course and making connections to other courses they had taken as well as to gain more feedback about the PBL course. The numeric results are shown in Table 3.

Table 3. Theoretical Coding Themes Mentioned by PBL1 Participants for July 2015 Questionnaire (*n* = 8)

Theoretical coding theme (positive (+)/negative (-))	Number of participants
Design (+)	3
Group work (+)	2
Communication (+)	1
Contacting people (+)	1
Explaining in English (+)	1
Mechanical engineering concepts (+)	1
PowerPoint (+)	1
Research skills (+)	1
Technical English (+)	1
Time management (+)	1

Shift in PBL2 Course Content Based on PBL1 Results

We actively used the themes highlighted in Tables 1 and 2 to amend content for the course. This resulted in more critical thinking activities in English. Though critical thinking was not a direct theme derived from the data itself, as a core objective of the course we attempted to instill more critical thinking activities during course restructuring. Activities were added or amended throughout the course, but one particular additional activity exemplifies our attempt to address the positive and negative aspects indicated by the participants and the critical thinking elements sought by the instructors—the *Craggy Rock* activity.

The Craggy Rock Activity

Used in PBL2 for a bridge project (students were tasked with designing and building a small bridge that would hold 10 kilograms), the *Craggy Rock* activity was developed by the authors based on Morgan et al.'s (2013) STEM PBL engineering design process to help scaffold students into the main bridge-building project. In this scaffolded PBL activity, students looked at a particular place where a fictional mayor wanted to build a bridge. Specific conditions were set. Students then had discussions, using as much English as possible, to determine which type of bridge would be suitable. After arriving at a solution, student groups presented their results to the class, justifying the rationale behind their choice while using appropriate engineering vocabulary.

Eslami and Garver (2013) argued that structured group work such as this is beneficial in developing the technical engineering English proficiency as well as critical thinking skills of students. Morgan et al. (2013) identified seven steps inherent to the engineering design process of a project, especially for PBL education—identify problem and constraints, research, ideate, analyze ideas, build, test and refine, and communicate and reflect (p. 33). The *Craggy Rock* activity, as utilized in this PBL class, included steps 2 through 4 and 7 of the engineering design process, which allowed students to practice critical thinking for engineering in English before fully engaging in the actual building of their own bridge. This activity was a useful structured step towards a more complete understanding of the engineering design process.

PBL2 Student Reactions

Following are reactions to *Craggy Rock,* using the initial coding analysis method described above. Seventeen professional journal entries for the week the activity was conducted were used in the coding analysis.

Initial Coding Analysis

The initial coding analysis, based on data taken from PBL2 participants' professional journals, suggests high correspondence with the analysis of particularly positive aspects as defined in the PBL1 analysis (see Table 4).

Table 4. Theoretical Coding Themes From PBL2 Participants for Craggy Rock Activity, Professional Journals, Fall 2015 (n = 17)

Theoretical coding theme (positive (+)/negative (-))	Number of participants
Presentation (+)	10
Group work (+)	10
Design (+)	9
Communication (+)	7
Knowledge acquisition (+)	6
Technical English (+)	6
Interest (+)	6
Decision-making (+)	5
Aesthetics (+)	5
Refinement (+)	3
Problem-solving (+)	1
More mechanical engineering (-)	1

Of the top seven initial coding themes, six overlapped with the analysis derived from the PBL1 data—*presentation*, *groupwork*, *design*, *communication*, *knowledge acquisition*, and *technical English*. The one other entry was *interest*, which was marked when participants indicated *enjoyment* or *interest* in the *Craggy Rock* activity. This theme is, perhaps critically, absent from analysis of PBL1 data as enjoyment in the activity itself should motivate learners to engage more fully in the project.

Many of these themes align with aspects of critical thinking as described in the theoretical framework. *Decision-making*, mentioned five times, but not identified in the PBL1 analysis, describes the communicative effort that students went through to arrive at a focused answer. Students did not always agree and therefore had to provide reasoned arguments that would persuade their group members to support their plans and ideas. *Groupwork*, *knowledge acquisition*, and *problem solving* are a part of the foundational elements of PBL as derived from the literature (see Table 1). These themes are also representative of the way Capraro et al. (2013) described the link between critical thinking and PBL.

Furthermore, Mergendoller and Larmer (2015) identified eight essential characteristics of PBL that were used to ground the course and this study. We used elements such as *authenticity, student voice and choice, reflection,* and *critique and revision* to discover, develop, and implement *Craggy Rock*. Without the student feedback through their professional journals and questionnaires, we would not have been able to target with confidence the areas that needed refinement. Informed by the theoretical framework in an inclusive teaching, learning, and researching environment and through the use of the grounded theory technique of constant coding and contextual understanding, we developed a connection between theory and practice.

Discussion

Skills Encouraging Critical Thinking

As outlined above, some of the positive themes indicated by PBL1 participants in their PBL experience have an inherent critical thinking element included in such activities as *Craggy Rock*. These included *knowledge acquisition, technical English, idea communication in English,* and *design*. Eslami and Garver (2013) pointed out the importance of *knowledge acquisition*, *technical English*, and *communication in English* for the English portion of a PBL in an English course, and Morgan et al. (2013) emphasized the importance of understanding the engineering *design* process for STEM PBL courses. These ideas are made concrete in the *Craggy Rock* activity in which students are meant to express their opinions and offer solutions. In order to effectively discuss the problem in a group and present a solution in English to the class, *technical English* is required as well as *idea communication in English* to convey appropriate meaning. Finally, the fictional mayor in the activity also sets conditions for *design* features, which in turn required students to think critically about such features when choosing the appropriate bridge as a solution.

Conclusion

In this paper, the authors outlined the theoretical background of their research and their use of research collected from a larger longitudinal project on PBL in English for Japanese engineering students. Initial theoretical coding of data collected from the PBL1 course revealed positive and negative aspects to the course. The instructors used those results to develop critical thinking activities such as *Craggy Rock* to improve positive aspects (*presentation*, *group work*, *design*, *communication*, *knowledge acquisition*, and *technical English*) and eliminate negative aspects (*time-consuming* and *more English*). Analysis of students' professional journals for *Craggy Rock* indicated that many of the positive aspects were maintained in this activity for the second iteration of the course with none of the negative aspects revealed in the first iteration. Furthermore, student participants expressed *enjoyment* for *Craggy Rock*, which was not identified in the first iteration. The scaffolding aspect of *Craggy Rock*, in which students did not do the more time-consuming aspects of the engineering design process as described by Morgan et al. (2013), might be crucial to this change. Finally, more longitudinal qualitative research studies about classroom practices and how they affect students in the immediate course and throughout their lives is necessary to assess the wholistic value of their English language courses.

Bio Data

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