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Project-Based Learning in APU's New Science English Course

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Abstract

Project-based learning (PBL) is a method of instruction which integrates language, content, and skills. PBL emphasizes active, self-directed learning and is an effective method for engaging students in learning and providing opportunities for improving both language proficiency skills and content language knowledge. This paper presents a brief introduction to PBL, the rationale for using this method in Akita Prefectural University's (APU's) new Science English course, a description of how the projects were implemented, and the results of the end-of-course questionnaire. Eighteen first-year APU Bioresource Sciences students participated in the author's new Science English course and completed the final questionnaire. Results of the survey suggest that the new course was effective for helping the students become more aware of global issues related to the environment, improving their research and presentation skills, and enhancing their motivation for learning English.

Keywords: Active learning, collaborative learning, content-based instruction (CBI), environmental education, interdisciplinary, project-based learning (PBL), student engagement

Project-based learning (PBL) is a student-centered approach to learning in which students are engaged in inquiry over an extended period of time. Successful PBL focuses on real-world subject matter that interests students, requires student collaboration, allows for autonomy, has a purposeful focus on language form, and is process- and product- oriented (Alan & Stoller, 2005). Some of the benefits of PBL for English language learners include exposure to authentic materials (materials written for native speakers), opportunities to use the target language in meaningful ways, and the simultaneous development of content knowledge, communication skills, and critical thinking skills.

Project-based learning was selected by the instructor of Akita Prefectural University's (APU's) new Science English course to provide the students with a useful and practical learning experience, which would link English language learning to the courses in their majors and help them develop interdisciplinary understanding. Research suggests that incorporating content-based instruction (CBI), which integrates language skills and content," is an effective way of creating a stimulating and engaging environment in which language use is natural, relevant, and purposeful" (Nagahashi & Duell, 2008, p.41). Collaborative learning in the Japanese university context is useful for enhancing involvement in the learning process, increasing motivation, and improving English language proficiency (Nagahashi, 2014). Moreover, collaborative science-based projects provide opportunities for motivating, meaningful, and enjoyable learning (Sharpe, 2015).

In short, PBL is an effective instructional approach which provides opportunities for students to actively engage in the learning process, collaborate with others, and improve language proficiency, content knowledge, and critical thinking skills.

The purpose of this study was to assess the students' response to APU's new Science English course and the efficacy of the course for enhancing the students' awareness of global issues related to the environment and ways to promote sustainability, enabling them to conduct science research and present their findings in English, and improving their motivation for learning English.

Methods

This study used both quantitative and qualitative methods to assess the students' response to APU's new course, Science English. A questionnaire, which included closed and open-ended statements, was administered at the end of the course. All of the students (N=18) who participated in this course completed the end-of-course questionnaire. The data collected from the nine closed-ended statements were analyzed using Excel statistical software (Microsoft Corporation). Means and standard deviations were calculated for each of the nine closed-ended statements. Open-ended statements and questions were used to obtain information which would give greater insight into the effects of the course on the participants.

Participants

Eighteen Akita Prefectural University (APU) students (9M/9F) participated in the author's Science English course during the spring semester of 2015. All of the participants were first-year students enrolled in programs on the Akita campus of APU (see Table 1). All of the participants took the TOEIC Bridge test prior to starting the course and attained a total score of at least 150, which was a requirement for this new course. A TOEIC Bridge test score of 150 is equivalent to a TOEIC test score of approximately 470 (Educational Testing Service, 2012). Science English is a special course, which first-year APU students have the opportunity to take in lieu of the required CALL I course if they meet the requirements. Science English is a 2-credit course that meets for 90 minutes once a week for 15 weeks for a total of 22.5 classroom contact hours. This course was taught by the author during the first semester of the 2015 academic year.

Table 1
Participants (*N*=18)

Group	N	Department
2015 APU Freshman	18 (M9/F9)	Biotechnology (*n*=7) Biological Production (*n*=6) Biological Environment (*n*=3) Agribusiness (*n*=2)

Materials and Procedures

A variety of materials were used in the new Science English course including six books from the National Geographic *Global Issues* series by Cengage learning, science articles, and handouts created by the author. The National Geographic *Global Issues* series and science articles were used to provide the students with exposure to authentic reading materials, raise awareness of global issues related to the environment, and provide a starting point for their research projects. The "above-level" (US 8th Grade Reading Level) books selected from the *Global Issues* series were *Climate Change, Energy Resources, Food Supply, Habitat Preservation, Pollution* and *Water Resources.* Two science articles, one written by APU professors, "Oil Adsorbent Produced by the Carbonization of Rice Husks" (Kumagai et al. 2007), and another written by APU undergraduate students, "Red Mulch vs Black Mulch in Early Tomato Production" (Hotta & Kashiwa, 2011), were used to teach students how to read science articles written in English. Handouts created by the instructor were used to

provide additional information and instructions for the projects. For their research, the students had access to the Internet, the APU library, APU faculty and staff, and the materials and tools needed for their projects.

Environmental sustainability was chosen as the overarching theme for the course to link the global issues topics together and because it is a key issue facing the world today. In order to respond to the challenges of creating a sustainable society, Japanese university graduates need to be equipped with "holistic knowledge," which means a wide range of knowledge, and core competencies, including communication skills, collaboration skills and problem-solving skills (Tamura & Uegaki, 2011).

Students enrolled in the new Science English course completed two collaborative science-based research projects during the 2015 Spring Semester. The projects started in the second week of the course, after the students had given short PowerPoint presentations, which the instructor used to make a quick assessment of their awareness of global issues related to the environment, English language proficiency, and research and presentation skills. The following sections will explain the goals and objectives of the research projects, and the procedures that the instructor followed for implementing the two projects.

Procedures

Goals and Objectives. The main goals of the collaborative science-based research projects were to acquaint the students with a variety of environmental sustainability issues relevant to their majors, help them develop the knowledge and skills that would enable them to conduct science research using primary and secondary source methods, and help them learn how to present their research findings in the two standard formats used for scientific presentations, poster and PowerPoint.

The objectives of the collaborative science-based research projects were to help students:

- understand and follow the steps of the scientific method;
- understand how to gather relevant information from multiple sources, including primary and secondary sources;
- learn to critically assess and organize the information in a coherent manner;
- avoid plagiarism by quoting or paraphrasing key points;
- understand and use the standard, Introduction, Methods, Results, and Discussion (IMRD), structuring for scientific research posters;
- understand how to design PowerPoint slides for a scientific presentation;
- learn how to present visually appealing and informative scientific research posters and PowerPoints.

Science-Based Project Number One. The first project lasted for six weeks and ended in a poster presentation of the research findings. The project began with a review of the scientific method, instructions for gathering relevant information from primary and secondary sources, and learning how to read a scientific article. Then the students divided into six groups of three members each and selected one of the topics from the National Geographic *Global Issues* series, climate change, energy resources, food supply, habitat preservation, pollution, and water resources. Next, the groups decided the focus of their research, completed the project handout (see Appendix A), and discussed the project with the instructor. After receiving approval from the instructor, the group could proceed with the project.

One of the requirements of the first project was that students include information from a primary source, such as data collected from a survey or information gathered through direct observation. To fulfill this requirement, the students

conducted interviews and surveys, performed experiments, joined ongoing research projects, and directly observed problems in the environment (see Table 2).

Table 2
Science-Based Project Number One: Topics, Titles, and Primary Sources

Project One Topics	Project One Titles	Primary Sources
1) Climate Change	"*Uchimizu*- Easing Global Warming"	1. An experiment on the effects of sprinkling water on different types of ground surfaces. 2. Consultation with professors from the APU Faculty of Bioresource Sciences.
2) Food Supply	"Understanding Food Waste"	1. An original survey on the value of food being wasted in the APU dormitory cafeteria. 2. Measurement of the amount food being wasted at APU's school and dormitory cafeterias.
3) Energy Resources	"Do APU Students Think Wind-Generated Electricity Is Good for the Environment?"	1. An original survey on APU students' opinions of the merits and demerits of wind-generated power. 2. Direct observation of windmills located near the APU campus.
4) Habitat Preservation	"Habitat Preservation: Let's Protect Our Pine Trees"	1. Participation in APU's research project on pine wilt disease (*matsugare*). 2. An original survey on APU students' interest in pine wilt disease.
5) Pollution	"Does Fertilizer Runoff from Paddy Fields Cause Algal Bloom?"	1. Direct observation of local paddy fields. 2. Interview with APU professor studying algal bloom in Lake Hachiro.
6) Water Resources	"Saving Water"	1. Original survey on APU students' methods for saving water.

At the end of the six-week period, the groups presented their findings in a poster presentation. Before the presentations, the students were given instructions for creating, printing, and presenting the posters. All of the posters were checked by the instructor before the presentation. The poster session was arranged to allow time for each member of the group to present the poster, view all of the other posters, and complete self- and peer evaluations.

Science-Based Project Number Two. The second project, which focused on sustainability, lasted for 12 weeks and culminated in a PowerPoint presentation. One of the requirements of the second project was that it included a hands-on experience (see Table 3). The students initially divided into three main groups. The first group, which consisted of 10 members, started the project by volunteering at an APU sponsored, two-day event, The *Nanohana* (rapeseed flower) Festival, May 30-31, 2015 (http://chokai-nanohana.jimdo.com/ ; http://akita-nanohana.com/). This annual event, which takes place near Mount Chokai, promotes rapeseed as a sustainable source of food and energy. Akita campus students, who volunteer for this event, prepare displays, demonstrations, and activities for educating festival visitors about the benefits of rapeseed. The second group, which consisted of four members, focused on waste management. This group experimented with the thermophilic composting of wastes from the APU Akita campus (food waste from the school's kitchen, shredded paper waste from the offices, and organic waste from the campus grounds) combined with local agricultural wastes (rice husks, rice straw and steer manure). The third group consisted of four members and was interested in sustainable fashion. The hands-on component of this project was growing cotton from seed.

Table 3
Science-Based Project Number Two: Topics, Titles, and Hand-on Experience

Project Two Topics	Project Two Titles	Hand-on Experience
1) Consumption	"Sustainable Fashion"	1. Growing cotton plants from seed.
2) Energy Resources	"Biodiesel Fuel from *Nanohana* (rapeseed)"	Volunteering at the 2015 Akita *Nanohana* (rapeseed flower) Festival
3) Food Supply	"Rapeseed Oil: A Nutritious Edible Oil"	1. Creating and presenting educational materials on biodiesel made from rapeseed oil.
4) Natural Resources	"The Relationship between Soil and Microbes"	2. Cooking with rapeseed oil 3. Creating and presenting educational materials on soil microbes.
5) Waste Management	"Compost"	1. Thermophilic composting of APU wastes (kitchen, office, and grounds) and local agricultural wastes (rice husks, rice straw, and steer manure).

At the end of the research period, the groups presented their findings in PowerPoint presentations. Before the presentations, the students were instructed in how to design the PowerPoint slides and provided with an outline for their speech. All of the group members were required to have a speaking part during the presentation. After the presentations, the students completed a self-evaluation.

Results and Discussion

At the end of the 2015 Science English course, students completed a questionnaire (see Appendix B). The questionnaire consisted of one question about their understanding of global issues, nine closed statements and 10 open-ended statements. A 5-point Likert scale in which 1 represented "strongly disagree" and 5 represented "strongly agree" was used. All 18 students, who participated in the new Science English course, completed the questionnaire. Quantitative results, means and standard deviations, for the nine closed statements were calculated (see Appendix C)

Both the quantitative and qualitative results of the questionnaire show a positive response to the new Science English course. Mean scores ranged from a low of 3.94 to a high of 4.56, which indicate a high level of agreement. Responses to the 10 open-ended statements illustrate that the goals and objectives of the projects had been met. To provide more structure to the discussion, the results have been divided into three sections: 1) content knowledge (questions 1and 2), 2) research and presentation skills (statements 3-6), and 3) student engagement and motivation (statements 7-10). In these sections, the percentage of students who gave a 'high' rating, a 4 or 5 on the five-point scale for each statement, and sample student responses to the open-ended statements will be presented. First, we will look at the responses related to content knowledge.

Content Knowledge. The purpose of integrating global issues into the new Science English course was to give the students a basic background in a variety of topics relevant to their majors, enhance their awareness of pressing environmental issues, and help them learn about things they can do in their daily lives to promote sustainability.

In response to statement number one, 94% (n=17) agreed that Science English improved their understanding of global issues. Responses to question number one and the open-ended statement and question that appear in number two indicate an awareness of some of the issues related to environmental sustainability and what they can in their daily lives to help reduce their impact on the environment (see Table 4).

Table 4

Sample Student Responses to the End-of-Course Questionnaire: Questions One and Two

1. What is the most interesting/important thing that you learned about each of the following topics?	
Topic	Sample Student Responses
Climate Change	• "It is important to reduce CO_2." • "We have to worry about Global warming."
Energy Resources	• "Clean energy improves lives" • "It is important to use renewable energy." • "There is a limit to use fossil fuels."
Food Supply	• "I was interested in the pump which utilize the sunshine. The pump enriched living standard of farmers." • "There is many food waste in Japan."
Habitat Preservation	• "I am interested that the habitat is broken by slash and burn farming. However, for developing countries, the farming is necessary to live. This is very difficult problem." • "Many animals and plants have a risk of extinction." • "We have to stop deforestation."
Pollution	• "I am interested that in China, air pollution is very serious and the influence spreads to other countries". • "The human actions have a big influence on environment."
Water Resources	• "We need to limit the amount of using water because people in advanced countries uses unnecessary water." • "I am interested that the sea is very wide and has a vast marine ecosystem, but it is dilicate and easy to be broken."
2. 1. I think that sustainability means… • "that all people can continue to protect our earth." • "we can continue for a long time and doesn't harm environment."	
What is one thing that you can do in your daily life to promote sustainability? • "throwing out the garbage with classifying." • "When I wash the dishes, I save water and I will use eco-friendly washing liquid." • "Don't use car. I use bicycle to go to shopping (the radius of 15 kilometers)." • "not wasting foods and so on."	

Research and Presentation Skills. English is the universal language of science. Therefore, it is essential that Japanese university science majors have the ability to conduct research and communicate their findings in English. In response to statement number three, 89% (n=16) agreed that they had learned how to conduct basic research in English. Three sample responses to the open-ended statement, "The most important thing I learned about doing research in English is…," are:

- "copy-and paste is no good!! I have to express my word. "3" is very important and magic number!!"
- "surveying smaller and deeper."
- "using book which is written in English. I have to read primary sources and secondary sources."

For statement number four, 83% (n=15) indicated that they had learned how to make and give a poster presentation in English. Responses to, "The most important thing that I learned about making a poster presentation is…" included:

- “making poster which it is easy to see for listener.”
- “It is important to do something systematically.”
- “nice pictures and good summary. I think also a loud voice is important too.”

Seventeen students responded to statement number five, and 78% (n=14) agreed that they had learned how to make and give a PowerPoint presentation in English. Responses to, “The most important thing that I have learned about making a PowerPoint presentation in English is…” included:

- “it is most important to speak watching listener reaction.”
- “(title --- overview---Transition 1---Main point1...--- Conclusion) I thought this form is easy to understand for listener”

Seventeen students responded to statement number six, and 72% (n=13) agreed that their English language skills had improved. Responses to “Before this Science English course I … Now I…” included:

- “Before this Science English course I couldn’t express my opinion using words. Now I can express using my words and I can feel that English is very interesting.”
- “Before this Science English course I had never doing presentation of science. Now I can make poster and powerpoint by rules.”
- “Before this Science English course I don’t like English. Especially English conversation. Now I like English conversation. My listening skill is grown.”

In summary, the sample responses in this section suggest that the students were able to develop the skills necessary for conducting science research using primary and secondary resources methods and presenting research findings in the two most commonly used scientific presentation formats, poster and PowerPoint.

Student Engagement and Motivation. Student engagement and motivation are the keys to academic success and an indicator of educational effectiveness.

Sixteen students responded to statement number seven, and 67% (n=12) thought that their motivation for learning English had improved. In response to the statement, “Before this Science English course I …Now I …”comments included:

- “Before this Science English course, I though that English in college is very difficult. Now I feel that expressing with using English is very interesting and I want to learn.”
- “Before this Science English course, I am afraid of speaking English. Now I am enjoying learning many things in English.”
- “Before this Science English course I worried about this class because I hear this class is very difficult. Now I want to read English books and I want to touch English more.”
- “Before this Science English course I didn’t like English. Now I am fearless of doing presentation in English!”

Seventeen students responded to statement number eight, and 67% (n=12), found working with class members useful. Responses to “My favorite project was _____ because…” included:

- “My favorite project was PowerPoint presentation because our grop members could unite.”
- “My favorite project was soil because I learned a lot about the relationship between microbes and soil.”

- "My favorite project was final presentation because it was very hard, but it became a chance to raise our English skil"

Seventeen students responded to statement number nine, and 72% (n=13) were satisfied with their effort. On average, the students spent 3.7 hours a week doing work for the course.

In response to statement number ten, five students expected to receive an A because of the amount of time and effort that they had put into the course. Twelve students expected to receive a B and one student expected a C. Some thought that they should have studied harder for the quizzes and others mentioned that they should have worked harder on their projects.

In short, the sample responses in this section suggest that the projects were effective for helping students develop a more positive attitude toward learning English, enhancing their motivation for learning, and increasing the amount of time and effort they put into their studies.

Conclusion

This paper has presented a short introduction to project-based learning (PBL), described two collaborative science-based projects, which were implemented into APU's new Science English course during the Spring Semester of 2015, and discussed the students' response to the new course. As illustrated by this study, project-based learning can be an effective method for simultaneously developing students' English language skills and content knowledge. Implementing effective project work into Japanese university EFL classes, however, is not without challenges for both teachers and students. For teachers, PBL requires careful planning, implementing, and facilitating in order to maximize the benefits. For students, there needs to be a willingness to engage more deeply in the learning process and to spend the extra time and energy that is often necessary for a successful outcome.

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Appendix A
Science Research Project One Handout

Science English 2015

Project 1

Group Members:

Group Leader:

Global Issue:

Research Topic:

Hypothesis*:

Resources (print, digital, audiovisual, electronic) that we will use:

1) List of primary sources* (original events, documents and artifacts) Examples include newspaper articles, photographs, original surveys and interviews, or the original work of someone else such as the information found in scientific articles.

2) List of secondary sources (an analysis or interpretation of a primary source) Examples include news reports, dictionaries, encyclopedias, books (including textbooks), and journal and magazine articles.

*Hypothesis

Here are examples of the three most common formats.
1. a question, "Does fertilizer affect the growth of tomatoes?"
2. a conditional statement, "Fertilizer may affect the growth of tomatoes."
3. an If, then statement, "If tomato growth is related to fertilizer, then adding fertilizer will increase growth."

*You can find more information about primary sources here:
http://www.library.illinois.edu/village/primarysource/mod2/index.htm

Our Research Plan

Title of our project:

Aims of our project:

Responsibilities of each member:

1)

2)

3)

Appendix B

Science English End-of-Course Questionnaire

Science English 2015

Final Questionnaire

5 Strongly agree	**4** Agree	**3** Neutral	**2** Disagree	**1** Strongly disagree

Directions: Circle the number (5 4 3 2 1) that best reflects your agreement or disagreement with the statement. Then complete the statements below.

1. Science English helped improve my understanding of global issues. (5 4 3 2 1)

What is the most interesting/important thing that you learned about each of the following topics?

Climate Change	
Energy Resources	
Food Supply	
Habitat Preservation	
Pollution	
Water Resources	

2. I now understand what "sustainability" means. (5 4 3 2 1)

I think that sustainability means…

What is one thing that you can do in your daily life to promote sustainability?

I can promote sustainability in my daily life by…

3. I have learned how to conduct basic research in English. (5 4 3 2 1)

The most important thing that I learned about doing research in English is…

4. I have learned how to make and give a poster presentation in English. (5 4 3 2 1)

The most important thing that I learned about making a poster presentation is…

5. I have learned how to make and give a PowerPoint presentation in English. (5 4 3 2 1)
The most important thing that I learned about making a PowerPoint presentation is…

6. I think that my English language skills have improved. (5 4 3 2 1)

Before this Science English course I…Now I …

7. I think that my motivation for learning English has improved. (5 4 3 2 1)

Before this Science English course I…Now I…

8. Working with class members was useful. (5 4 3 2 1)
My favorite project was _____ because…
9. I am satisfied with my effort in this class. (5 4 3 2 1)
On average, I spent _____ hours per week on this course.
10. I expect my grade in this course to be (A/B/C) because…

Appendix C

Means and Standard Deviations for the End-of-Course Questionnaire Closed Statements 1-9 (*N*=18)

Statement	Mean	Standard Deviation
1. Science English helped improve my understanding of global issues.	4.56	0.60
2. I now understand what "sustainability" means.	4.00	1.00
3. I have learned how to conduct basic research in English.	4.33	0.67
4. I have learned how to make and give a poster presentation in English.	4.33	0.75
5. I have learned how to make and give a PowerPoint presentation in English.	4.35	0.90
6. I think that my English language skills have improved.	3.94	1.00
7. I think that my motivation for learning English has improved.	4.25	1.15
8. Working with class members was useful.	4.53	0.85
9. I am satisfied with my effort in this class.	4.00	0.88

Note: Scores are based on a 1 (*strongly disagree*) to 5 (*strongly agree*) scale.