



The Study of Problem Solving Process of E-book PBL Course of Atayal Senior High School Students in Taiwan

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Received 30 September 2015 • Revised 12 July 2016 • Accepted 17 July 2016

ABSTRACT

This research is a qualitative case research. The objects were eight senior high students taking information application program in Nan Oau Aboriginal Key Senior high school in Taiwan. The study was aim to design a project-based e-book making course for Nan Oau Aboriginal Key Senior high school by studying the Atayal handicraft art curriculums. The course had six units, including two free creation units, and three lessons per unit for a total of 18 lessons, 900 minutes. Collections of research data included the research notes, the teaching observation notes, the problem-solving examination forms, the e-book making evaluation forms, the interview outlines, and the students' learning sheets and homework. After collecting and cross analyzing the information, the main results were as follows:

- A) Most of the students were satisfied with this e-book making course.
- B) The students performed best in "the quality of problem solving", and "the attitudes of how they face problems" next. However, the ways how they "deal with problems" last, which should be enhanced.
- C) Their e-book works were all appreciated by professors, teachers, craftsmen, and students. During the problem-solving process, they faced problems with a positive attitude and displayed initiative and willingness to solve problems.

Keywords: problem solving, project-based learning (PBL), e-books, Atayal Tribe, senior high school students

INTRODUCTION

This study is part of the Taiwan Ministry of Science and Technology's far-reaching program "Study of Digitizing Project-Based Learning of Atayal Senior High School Students" which helps Atayal students attending Nan Oau Aboriginal Key Senior High School in Yilan County by enhancing their technological literacy and designing suitable technical courses that keep pace with ever-changing technology to cultivate their spirit of scientific inquiry.

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State of the literature

- The PBL teaching stages are summarized into five stages: A) be student-centered and give students opportunities to explore the theme; B) students and teachers establish the learning environment together and design problems to explore; C) encourage students to think and construct principles from learning activity concepts; D) encourage students to use cognitive tools and present their works in stages; and E) reinforce the learning initiative stage to help students develop their ability to work together.
- Problem solving is the processing of finding answers by individuals applying their existing knowledge and skills to tools and applications to meet the requirements of new situations. Because the new situations are unfamiliar and unknown, problem solving is regarded as a high-level mental activity model.
- There are three facets to assess problem-solving abilities: "attitude toward the problem", "problem-solving approach", and "problem-solving quality". The five grades were used to rank the student's problem solving abilities.

Contribution of this paper to the literature

- An analysis of the problem solving abilities assessment shows that Atayal senior high school students performed the best in "problem-solving quality", followed by "attitude toward the problem". However, further improvement is needed with regard to their "problem-solving approach".
- The Atayal students very much agree with the curriculum and teaching method. This study combines Atayal hand-weaving techniques as a preliminary course with e-book PBL production. They are satisfied with their work and hands-on e-book creation was a fun learning experience.
- Most participating students believed that they were given more freedom to create. They can solve problems by themselves or take advantage of peer discussions, instead of asking the teacher for help whenever problems arise.

The objectives of this study are as follows: A) To analyze students' problem solving abilities during the e-book design and creation process; B) To explore and discuss the e-books completed by the senior students of the Aboriginal Key Senior High School and analyze teacher and student assessments of the creations of each group; and C) To understand the thoughts senior students have on the problem solving process gained from creating e-books.

LITERATURE

Atayal

The Atayal are one of the ancient ethnic groups in China. Their ancestral land might be in southern China, and they may have been one of the first aboriginal groups in Taiwan (Tian, Z.Y., 2001; Digital Museum of Taiwan Indigenous Peoples, 2008).

In traditional Atayal society, weaving skills were deemed an important type of productive work for Atayal women that helps form an independent personality (Taiwan Aboriginal Cultural Knowledge Network, 2009).

Therefore, this study will introduce Atayal hand-weaving applications as the creative element for the e-book creation course.

Problem-based Learning Focus and Implementation Stages

Torp and Sage (1998) believed that problem-based learning encourages metacognitive development in students and the development of teamwork. They further postulated that, in learning situations that more closely mirror reality, problem-based learning encourages interplay between cooperation, negotiation, and inclusiveness while indirectly enhancing student's social skills.

On implementing PBL strategy courses, Musthafa (1997) proposed a seven-stage learning cycle (Lai, C. D., 2003) outlined as follows: A) Early stage: The teacher will tell students what they will learn prior to the course, guide their thoughts from various angles, and allow them choose or decide on the content to be learned. B) Establish a common knowledge base: Create an authentic learning environment for students to accumulate hands-on experience while the teacher guides the discussion of problems. C) Rich learning content: Encourage frequent interaction between students and peers so they may exchange opinions with each other. The teacher only needs to observe from the sidelines while maintaining the overall atmosphere and keeping the classroom under control. D) Present learning outcomes: Through the exchange of ideas among peers, develop the appreciation of others and the ability of self-reflection. E) Share experience: Through experience sharing and oral reports, increase the impact of learning between peers. F) Common knowledge base integration: After the previous learning stages, the teacher can help students to think, understand, and correct their opinions based on the experiences shared for the course to implement multiple cycles of summarization.

Other scholars (Gubacs, 2004; Krajcik, Czerniak, & Berger, 1999) postulated that the stages of PBL should include the following traits: A) define the theme and scope; B) guide the development of the problem; C) extend the basic course; D) implement project-based teaching activities; E) allow students and teacher to establish a common learning objective together; and F) utilize diversified assessments.

The aforementioned teaching stages of project-based strategies and the relevance of teaching are summarized into five stages for this study: A) be student-centered and give students opportunities to explore the theme; B) students and teachers establish the learning environment together and design problems to explore; C) encourage students to think and construct principles from learning activity concepts; D) encourage students to use cognitive tools and present their works in stages; and E) reinforce the learning initiative stage to help students develop their ability to work together.

Thus, this study will follow the above stages in designing the learning project and integrate Atayal hand-weaving techniques as a preliminary course. Then, students will be divided into three groups to complete their e-books.

Problem solving abilities

According to Sternberg and Gitomer (1996), problem solving is the processing of finding answers by individuals applying their existing knowledge and skills to tools and applications to meet the requirements of new situations. Because the new situations are unfamiliar and unknown, problem solving is regarded as a high-level mental activity model (Hunt, 1994).

Lee, T. Y. (2013) believed that when individuals encounter hardships that generate problems, based on the situation, they will come up with strategies to solve the problems in their minds. In this psychological problem-solving process, the learner's mental activities or actions will be shaped; and according to the problem to be solved, steps to solve the problem will be developed.

As for assessing problem-solving abilities, Huang, M. T., and Chen, W. D. (2004) summarized the four stage problem solving process, understand the problem, develop a plan, execute the plan, and review, proposed by Polya (1957) into three facets: "attitude toward the problem", "problem-solving approach", and "problem-solving quality". They used five grades to rank the student's problem solving abilities.

Therefore, this study will use this rating scale as performance indicators during students' problem-solving process at each stage.

EXPERIMENT

Study participants

Eight Atayal senior students attending the Aboriginal Key Senior High School participated in this study. The students are certified level C technicians for computer software applications and have basic IT skills.

In addition, there were 16 sophomores participated the "Results Exhibition" to give feedback of exhibit results and oral presentation of the 8 senior students.

Course design and plan

There are seven classes for a total of 21 sessions (1050 minutes). At the end of the semester, an exhibition will be held to showcase the results (see [Table 1](#)).

The course content includes the Atayal hand-weaving techniques preliminary course and the formal e-book creation curriculum designed with the 5-stages of PBL (see [Table 1](#)).

The 5-stages of PBL of the e-book creation curriculum were stated as follows:

The course content includes the Atayal hand-weaving techniques preliminary course and the formal e-book creation curriculum designed with the 5-stages of PBL (see **Table 1**). Qualitative and quantitative analysis will be used to understand students' problem solving processes and abilities.

- A) be student-centered and give students opportunities to explore the theme
- B) Students and teachers establish the learning environment together and design problems to explore
- C) Encourage students to think and construct principles from learning activity concepts
- D) Encourage students to use cognitive tools and present their works in stages
- E) Reinforce the learning initiative stage to help students develop their ability to work together

Table 1. Teaching schedule

Course title	Number of times	Course content
Atayal hand-weaving techniques and applications preliminary course	3 times 9 sessions, 450 minutes total	Coin purse, key purse, woven pen holder
E-book creation	3 times 9 sessions, 450 minutes total	Editing software instruction, data collection, e-book production
Results exhibition	1 time 3 sessions, 150 minutes total	Exhibit results and oral presentation, student interviews

Tools used

This study includes quantitative and qualitative research data, as explained below:

Qualitative tool

Qualitative data is based on interviews with students to understand their learning experience and views. And two Aboriginal education experts reviewed the interview outline for the content validity. This information is then coded and analyzed as follows:

Student interviews are indicated with "INT"; students are represented as "S1, S2, and S3" and so on; the date is coded in a "year, month, day" sequence. For example, "INTS1-1040625" represents that the interview results of the first student occurred on June 25, 2015.

Quantitative tools

Quantitative data includes the problem solving abilities assessment and e-book creation assessment, explained below:

A) Problem solving abilities assessment: this assessment is adapted from the problem solving abilities assessment proposed by Huang, M. T., and Chen, W. D. (2004), and three information technology and aboriginal education experts reviewed the assessment for the content validity.

The assessment criteria are graded with five grades, and assess the students' "attitude toward the problem", "problem-solving approach", and "problem-solving quality".

B) E-book creation assessment: this assessment is based on relevant domestic and foreign literature, and three information technology and aboriginal education experts reviewed the assessment for the content validity.

This assessment uses qualitative data to interpret the results and understand the performance of the e-books created by participating students.

Students can achieve a total score of 100 on the e-book creation assessment, and are assessed as follows:

- a. The e-book creation assessment includes design, page layout, teaching steps, text, pictures and videos, special effects techniques, and overall perception, accounting for 80%.
- b. The oral presentation assessment includes the introduction and discussion topics, vocal performance, and body language, accounting for 20%.

In this study, the categories and concepts were found by using different data for triangulation and cross-verification analysis.

RESULTS

Problem solving abilities analysis

The e-book PBL course is divided into five units and 17 problem solving stages. During each stage, students are assessed on three facets, "attitude toward the problem", "problem-solving approach", and "problem-solving quality", and assigned a score out of 5 points (see [Table 2](#)).

A description of the overall problem assessment checklist and statistical analysis follows:

Table 2. Problem solving process course content by unit

Unit	Stage content
Unit 1	1-1 Get to know e-books, 1-2 E-book creation instruction, 1-3 to 1-6 Class work, 1-7 Putting brains to use, 1-8 Search for pre-production tools and applications
Unit 2	2-1 Solve the task, 2-2 Hands-on creation
Unit 3	3-1 Correct e-book content, 3-2 Hands-on creation, 3-3 Software operation and application, 3-4 Applying internet tools
Unit 4	4-1 Creation
Unit 5	5-1 Hands-on creation, 5-2 Progress report and corrections

From [Table 3](#), we see that students scored an average of 4.1 for "problem-solving quality" in the overall problem solving process, indicating that the quality of their problem-solving is good.

They scored an average of 3.83 for “problem-solving approach”, indicating that their approach for solving problems can be strengthened.

Students averaged 3.99 for “attitude toward the problem”, indicating that although students showed a positive attitude toward problems and have the skills to solve them, they still had room for improvement.

Table 3. Problem solving abilities assessment overall descriptive statistical analysis (n=8)

Facets	M	SD
Attitude toward the problem	3.99	1.23
Problem-solving approach	3.83	1.26
Problem-solving quality	4.10	1.18

E-book production showcase

A total of three e-books were created. Group A’s e-book teaches Atayal pen holder weaving; Group B’s theme focuses on Atayal coin purse and key purse instruction; Group C’s theme is key and coin purse (see [Table 4](#)).

Table 4. Screenshots of e-books

Group	Figure 1	Figure 2	Figure 3
Group A			
Group B			
Group C			

E-book assessment results

The participating sophomores and teachers are invited to the results showcase at the end of each semester to review the three groups' e-books.

The assessment table includes three teacher assessments and 16 assessments from the sophomores. An explanation of the results of the assessments is given below:

Teacher assessments

According to the results of the teacher assessments (see [Tables 5-7](#)), the average performance of Group A's e-book is the most prominent for "teaching steps"; Group B's e-book average score is the highest for "page layout", "special effects techniques", and "overall perception", while their average score for "pictures and videos" is lower; Group C's e-book performance is lowest in "page layout".

Table 5. Teacher assessment results: E-book

E-book (80%)		Group A	Group B	Group C	M	Total Points Possible
1	Design	3	3	3	3	3
2	Page layout	20	22	18	20	25
3	Teaching steps	12	11	11	11	15
4	Text	8	8	8	8	10
5	Pictures, videos	8	7	8	8	10
6	Special effects techniques	5	6	5	5	7
7	Overall perception	7	8	7	7	10
Total		63	65	60	62	80

Table 6. Teacher assessment results: Oral presentation

Oral presentation (20%)		Group A	Group B	Group C	M	Total Points Possible
1	Introduction, discussion topics	7	8	7	7	10
2	Vocal performance	3	5	4	4	5
3	Body language	3	4	4	4	5
Total		13	17	15	15	20

Table 7. Teacher assessment results

	Group A	Group B	Group C	M	Total Points Possible
Overall total	75	74	80	76	100

Student assessments

The scores given by the 16 sophomores present (see [Table 8-10](#)) show that Group A's e-book performed the best in "teaching steps", while their average scores for "vocal performance" and "body language" are lower than the other groups; Group B's e-book performed the best in "page layout", "special effects techniques", "overall perception",

“introduction, discussion topics”, and “vocal performance”, while their average score for “pictures, videos” are lower; Group C’s e- book performance is lowest in “page layout”.

Table 8. Student assessment results: E-book

E-book (80%)	Group A	Group B	Group C	M	Total Points Possible
1 Design	3	3	3	3	3
2 Page layout	20	22	18	20	25
3 Teaching steps	12	11	11	11	15
4 Text	8	8	8	8	10
5 Pictures, videos	8	7	8	8	10
6 Special effects techniques	5	6	5	5	7
7 Overall perception	7	8	7	7	10
Total	63	65	60	62	80

Table 9. Student assessment results: Oral presentation

Oral presentation (20%)	Group A	Group B	Group C	M	Total Points Possible
1 Introduction, discussion topics	7	8	7	7	10
2 Vocal performance	3	5	4	4	5
3 Body language	3	4	4	4	5
Total	13	17	15	15	20

Table 10. Student assessment results

	Group A	Group B	Group C	M	Total Points Possible
Overall total	64	71	64	66	100

A summary of the above reveals the following three points:

- A) Both teachers and students thought Group A’s e-book excelled in “teaching steps”, while the students gave lower marks for “vocal performance” and “body language”.
- B) Both teachers and students thought Group B’s e-book excelled in “page layout”, “special effects techniques”, and “overall perception”. Group B’s didn’t perform as well on “pictures, videos”, but students gave Group B higher scores on “introduction, discussion topics” and “vocal performance”
- C) Both teachers and students gave Group C’s e-book lower scores on “page layout”.

Atayal student’s project-based learning

The participating sophomores and teachers are invited to the results showcase at the end of each semester to review the three groups’ e-books.

Agree with teaching method and had fun learning

Through observation and interviews, we found that the eight Atayal students very much agree with the curriculum and teaching method. They are satisfied with their work and hands-on e-book creation was a fun learning experience.

S1 student: I'm satisfied with the e-book and our presentation. Overall, I'm very satisfied. (INTS1-1031223)

S5: I like how the teacher taught us and the way the lessons were delivered. There was more interaction between the students. (INTS5-1031223)

S7: I liked everything! My favorite was the place to put pictures. The software was very interesting and I learned a lot! (INTS7-1031216)

S2: I liked adding videos and pictures. It was very interesting and fun! (INTS2-1031216)

This method of teaching creates more room for individual thoughts or peer discussions

Most participating students believed that they were given more freedom to create. They can solve problems by themselves or take advantage of peer discussions, instead of asking the teacher for help whenever problems arise.

S1 student: Classes were more free and different from the usual method of lecture and listen. We were in control of more things and had more freedom to create. (INTS1-1031216)

S3: We had more time to think and could solve problems through peer discussions even if we couldn't solve them ourselves. In the past, we always asked the teacher directly. We can actually solve many problems by ourselves. (INTS3-1031216)

S4: The lessons were different from the past. We were able to make arrangements instead of following the teacher step by step. We can try on our own first and then come out ahead of the teacher's progress. We can go ahead of schedule and then slowly perfect our work. (INTS4-1031216)

Cultivate a positive attitude and self-confidence when faced with a problem

During the problem-solving process, students can cultivate positive attitudes when facing problems. They are willing to take the initiative to find relevant information, thus enhancing their confidence in learning.

S1 student: When I first faced problems, I was afraid. But after a few explorations, I realized that I can solve problems by myself. So, I gained a lot of confidence and am not afraid of problems anymore. (INTS1-1031216)

S2 student: I first work hard at learning; then I find useful tools through the internet. (INTS2-1031216)

S7 student: Face problems bravely! Do not be afraid. Just solve them one step at a time. (INTS7-1031216)

CONCLUSION

This study combines Atayal hand-weaving techniques as a preliminary course with project-based learning to explore and research the problem solving process of aboriginal senior high school students during e-book production.

An analysis of the problem solving abilities assessment shows that students performed the best in “problem-solving quality”, followed by “attitude to-ward the problem”. However, further improvement is needed with regard to their “problem-solving approach”.

The results of the e-book creation assessment indicate that A) both teachers and students thought Group A’s creation performed best in “teaching steps”; B) both teachers and students thought Group B’s creation performed best in “page layout”, “special effects techniques”, and “overall perception”; and C) both teachers and students thought Group C’s creation performed relatively poorly in “page layout”, while results of the other aspects were good.

In considering what all three groups lack in comparison, “page layout” has the most room for improvement.

The student interviews revealed that most students liked the e-book production course and thought that the course was interesting and creates room for personal or peer development. During the problem-solving process, they faced problems with a positive attitude and displayed initiative and willingness to solve problems.

Since this was a case study, we suggest that related researchers conduct quasi-experiments and include other tribes for comparison to understand whether participating students can improve their problem-solving abilities through project-based learning.

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