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The research of 4th grade mathematical curriculum electronic picture book construction and development in integrating indigenous culture

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Abstract. This research aimed at integrating Seediq culture and mathematical course design for fourth-grade elementary school, and then transforming this mathematical course into an electronic picture book. During the process of electronic book development, the researchers collected videos of six participants engaged in discussion, reflection minutes after the meeting written by the attendants, the researchers’ observation and review journals, and conversations with the participants. Then, researchers utilized Content Analysis to explore, try, review and retry steps of electronic book making process. The main findings: There are four periods of electronic book making process, research occurrence period, curriculum design period, electronic book transformation period, and result evaluation period. The picture book included the White Stone Legend born from Seediq seniors, historical battle for hunting field between tribes, and concepts of approximation, angle, triangle, and quadrangle features. At last, with the research result, this article presents the corroboration of related works, and then proposes suggestions of electronic book teaching and follow-up studies.

1. Introduction

In the past, a lot of research [1, 2, 3] has indicated that the teaching activity design in normal mathematical classrooms rarely pay attention to the learning of underprivileged students and the students from minority ethnic groups. Hence, some countries (America, Canada, and Australia) actively participate in making materials [1, 2, 3, 4] suitable to students’ basic knowledge and culture. Besides, Ministry of Education emphasized, in general program of 12-year compulsory education, on curriculum demands considering multicultural and ethnic diversity. Earlier studies [2] have also mentioned that native indigenous students have no interest in learning math and show poor academic performances. targeting the dominant culture might result in such situations [1]. Accordingly, designing mathematical materials, which is based on the prior knowledge of the students from minority ethnic groups and their cultural, is a task worthy putting effort on.

However, looking around native 16 indigenous groups, Seediq was recognized as the 13th indigenous group officially in 2008. It was relatively a new group identified by the Indigenous Committee. There are 48 essays focusing on Seediq culture in the National Library theses and dissertations system. There are total 43 theses focusing on Seediq culture in journal theses system, and only two of them
considered teaching to Seediq students [5]. Obviously, it is highly important to consider culture while developing math curriculum for Seediq students.

Furthermore, most students like picture books with plots [6]. Reading illustrations and words in a book is as interesting as watching dramas [7]. Employing picture books in education improves learning of new knowledge and language, enhances reading ability, and cultivates creativity [8]. Yet, as technology developed, the Ministry of Education mentioned that we should understand the influences of science and techniques to humans, and learn how to utilize and manage science as well as skills in Grade 1-9 (Curriculum Guidelines: Science and Technology learning area). Electronic books are the emerging multi-media products in this context. Teaching through electronic books not only stimulates students’ visuals, which help them in learning math actively [1], but also makes them learn faster [9]. Combining picture and electronic books and equipping them with sound, voice and animation transforms the static learning system into a dynamic one. It also works as an appropriate teaching material, which is responsive and has immediate implications as per the learning schedule and students’ demands [10].

In summary, this study focusing on Seediq culture attempted to develop mathematical learning materials (this research utilized the myth: White Stone Legend and the history of ethnic conflict) for Seediq children in the 4th grade and added concepts of approximation (4-n-06), angle (4-s-01, 4-s-04, 4-s-05), triangle, and quadrangle (4-s-07). Then, a mathematical learning curriculum focusing on indigenous culture was developed, which is then transformed into an electronic picture book. Through the process of electronic picture book development, we aimed to determine the significant of this process in the math learning among 4th grader Seediq students.

2. Theoretical foundations

At present, the process of learning and teaching emphasizes the importance of “reflection”. Reflection is that a learner reflects in action, which is the key to learn [11]. In order to abound mathematical learning materials for Seediq students, this research considered act of researchers as well as six students aspiring to become teachers. During the process, the researchers reflected on existing problems and proposed certain problem solving strategies, which became the research aim in the next period and was then carried out. Furthermore, the researchers found new problems, reflected, and then purposed new problem solving strategies and action project, while carrying out the project. The strategies mentioned above were consistent with the group cooperation, conversation, judgments, reflection and problem solving direction in action research [12].

3. Research design

3.1. Research situation

With a goal of developing mathematical curriculum electronic picture book based on Seediq culture for 4th grade elementary students, the researchers recruited six students undergoing teacher-training from their working school, who were interested in learning of indigenous students with hope to improve their mathematical teaching knowledge to carry out the six-month research and development process. The researchers utilized their past mathematical curriculum experience based on indigenous culture and suggested six steps for the electronic book development: culture analysis, curriculum analysis, story context, mathematical problem production, peer judgments and revision, picture book painting, and electronic producing. The given figure 1 and Table 1 explain each step.

3.2. Research participants

Among the six students in teacher training, one (Xuan) is the second grade college student of Cultural and Creative Industry Design and Management Department, and the other five (Han, Cheng, Hao, Qiao, Jay) are college students of Mathematical Education Department (four juniors and one freshman). During the past year, they followed researchers in integrating Tsou culture with mathematical curriculum design hence they were having some related experiences.

3.3. Research tools: electronic book producing tool
The software chosen to produce electronic picture book was Zmaker, electronic book producing master software, which is easy to learn for a new user. Therefore, the researchers chose this software to produce electronic picture book.

3.4. Data collection and analysis
The collected data included weekly conversation videos (25 minutes in total), reflection minute written by the six students in teacher training after every meeting (150 in total), and the researchers' observation and review journals after meeting (25 in total). For this data analysis, the researchers utilized “Analysis Induction” because all data collected in this research were of qualitative nature. In the process of electronic book development, the researchers had a close look at the data in every category point by point in the line of “time”, cross-compared the qualitative content of the participants’

Figure 1. Operating procedure of picture electronic book producing

Table 1. Each steps and detail in this research

<table>
<thead>
<tr>
<th>step</th>
<th>time</th>
<th>detail explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. culture analysis</td>
<td>103.12</td>
<td>1-1. collect and read literature related to Seediq</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-2. visit Seediq tribe in person</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-3. visit school teachers in Seediq tribe</td>
</tr>
<tr>
<td>2. curriculum analysis</td>
<td>104.01</td>
<td>2-1. analyze context in mathematical textbook of 4th grade student</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2-2. understand 4th grade students’ mathematical prior knowledge</td>
</tr>
<tr>
<td>3. story context and mathematical problem construction</td>
<td>104.02</td>
<td>3-1. add Seediq culture into story plot</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3-2. add mathematical conception and problem in story plot</td>
</tr>
<tr>
<td>4. peer judgement and revision</td>
<td>104.03</td>
<td>4-1. encourage teachers in tribe to proofread story and mathematical question</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4-2. revise work according to suggestions provided by tribe teachers</td>
</tr>
<tr>
<td>5. paint picture book</td>
<td>104.04</td>
<td>5-1. design pictures and discuss</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5-2. color pictures and typesetting</td>
</tr>
<tr>
<td>6. produce picture electronic book</td>
<td>104.05</td>
<td>6-1 seek multi-media (voice, animation) to upgrade the value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6-2. electronic page editing and producing</td>
</tr>
</tbody>
</table>
conversation and words in the way of induction and analysis, found problems emerging during a period with the help of the verification of “reflection journals” written by the researchers, and made “action project” to reflect and solve problems as well as practice the situation.

3.5 Research authenticity examination
Authenticity of this research was validated by 3-side cross examination of the “different data” (for example: conversation video, reflection minute and reflection journal after a meeting) and “different participants”. One researcher (R1) with others having PhD degree was mainly in charge of the 3-side cross examination of “different participants”; they picked one ten corresponding to each other of the data randomly to categorize them.

4. Research result and discussion
At the beginning of the electronic picture book development, the researchers foresaw difficulties during the research due to the lack of a previous design presenting integration of indigenous culture with mathematical curriculum. Hence, with the spirit of research, they tried to report problems emerging during the process of electronic book development, reflected on problems faced, and made a new action project to solve the problems.

4.1. Problem analysis and new action project

4.1.1. Problem analysis I. This study considered the Seediq culture in all aspects including cuisine, clothing, architectures, mythology, and legends. Therefore, the researchers decided to embark both the aspects of the culture: the “static: ancient books and historical records” and the “dynamic: visiting school teachers in the village”. They found that "much information about the Seediq culture is not available on the Internet or in the libraries (J 1-03)".

4.1.2. New action project I. After thinking carefully, the researchers decided to turn to a professor. The professor was in contact of several students, and was under the charge of principals and directors in Nantou County. Then it was possible for him to find those who are Seediq. As expected, they ended up finding two Seediq teachers. "They saw many architectures and utensils through the lead by the two teachers (M2- Hao-05)". The researchers found "school teachers who can offer consultation in the tribe through connection, but they still hoped to seek more cultural information different from the oral history or entity (J 2-15)".

4.2. Problem analysis and new action project in picture book design period

4.2.1. Problem analysis II. After obtaining enough cultural data, the researchers started cultural analysis. However, the analysis of the Seediq cultural objects. (clothes, houses, and rice mashers, see figure 2) found that the mathematical concepts hidden in them were most geometrical. “I found that most mathematical concepts hidden in these houses and clothes are related to a plane figure (M 3-Jay-18).” "I found that the shapes of wooden houses and stone houses mostly are a kind of rectangle and parallelogram as well (M 3-Hao-20)."

Figure 2. Seediq objects
4.2.2. New action project II. Regarding the problems in the process of culture analysis, the researchers asked: “According to van Hiele’s geometry cognition level, these concepts superficially seemed plane geometry only and should be elevated to geometry quality analysis level (J3-13). Therefore, the students in the teacher-training meditated, “These cultural objects mostly belong to geometry concepts. Apart from knowing geometrical figures, are there other ways to elevate the problem level and inspire the children to think?” (M 4-T-27).” With the help of this guide, one student got an idea that “Seediq ethnic group has White Stone Legend and some battles with other ethnic groups: “We can combine them into a story then think mathematical problems related to the story (M 4-Qiao-35)”.

4.2.3. Problem analysis III. However, after meditation and construction of trial problem, a researcher said, “The problem construction this time was too similar to handouts. Problem construction in this way was no different than the general handouts (M 5-T-38)”. “Take Jay’s problem for example: There are 124 Taroko adults. Problem: How many people are there after approximating to the nearest tenth? This was alike the problems in textbooks, and the only difference is the addition of Taroko people (M 5-T-39)”, a teacher said. Besides, Han also said, “I have a difficulty while designing problems, which is hard to use two concepts in one situation (M5-Han-42).” This difficulty also exists in Hao’s reflection: How to combine two math concepts in one context? It is a little bit difficult. “It seems hard to enter geometry and other themes if the situation is number and calculation (R5-Hao-07)”.

4.2.4. New action project III. Having difficulties as mentioned above, the researcher guided their thinking: “Another path of teaching is to make students learn math concepts through “doing by hands”. The current math teaching focuses on ability cultivation. "We should cultivate children’s ability of speaking reasons and make them express their thoughts (M 6-T-15~17).” Structure of culture integrating mathematical context is shown in figure 3.

![Figure 3. Structure of culture integrating mathematical context](image)

Then, people discussed about the problems designed in this structure. Take Hao’s problem for example: Sabu shoots birds in the sky. Problem: How many degrees is the elevation angle of this arrow shot? After discussion, it became a problem for verification (figure 4). The researchers judged the design of the problems, “after this discussion, we came up with many different thoughts and changed most common mathematical problems into problems belonging to the verification (R 8-Cheng-05). “After a brainstorm, the standardized mathematical problems are verified making them more and more flexible… (J 13-07)”, a researcher noted. By peer judging and revising the problems one by one, the group finished revising all the mathematical problems in the cultural context.

In the next step, the group was ready to produce an electronic book. First, the participants had a discussion about the drawing idea. “As for the drawings in picture books are concerned, after a discussion, we decided it is all up to Xuan (M 14-Han-05–06).” It turns out that “…according to my impression, indigenous people have rectangular faces; I therefore, draw so (M 14-Xuan-09).” The case proves that “the characteristic of the roles would be subtly embedded with the drawer’s impression of indigenous people (J 14-Xuan-06) (figure5).” But Jay had a different idea of it: “I think it is okay to make a cute version, which is more attractive to students (M14-Jie-18).”

Figure 4. Problem of verification

4.3.1. Problem analysis IV. In response to the question from the researcher, Hao said, “... in position of readers, how we can tell it as Jimmy’s work, once seeing his drawings? It’s because of his unique drawing style. Therefore, I support Xuan for keeping her unique style (M 15-Hao-09–11).” By digging into the spirit of picture books and self-reflection, the participants reach the decision of “respecting the original ideas”, which make the figure of characters as most vivid feature of the picture book.

4.3.2. Problem analysis V. The following step is about feeding the drawings on paper into electronic book producing software, Zmaker. “... At the beginning, the electronic book presents the idea of our design, helping readers know the concept with which we design the picture book and the grade and the units, it suits (M 16-Hao-05).

4.3.3. New action project V. Conceding the lack of sound effect and animation in the electronic book as purposed by the peers, Han decided to be in charge of animation production. As for sound effect, Qiao suggested “It should be some different human voices to cooperate with one another (M 17-Qiao-12)”, which got much recognition.

5. Conclusion and suggestions
In conclusion, this research was aimed at designing an electronic picture book integrating Seediq culture with mathematical curriculum for 4th grade elementary school. Through the cyclic process of action research “problem analysis → reflection → constructing and carrying out new action project”, the research group overcame the difficulties associated with this rare culture, incapability of finding corresponding mathematical concepts in the culture, picture book production, an electronic picture book equipped with animation and sound effects, and finally completed the electronic picture book. Besides, with the help of teaching demonstration in person, the researchers ameliorated the tribal teachers’ worries that “schedule would be delayed due to this” and “students would learn less due to this”, then successfully persuaded the teachers to teach with electronic picture book in person. Finally, the tribe teachers realized that this electronic book, integrating culture and mathematical concepts, does improve learning motivation among students and gives them a sense of familiarity in mathematical problem solving.

From Seediq cultural context, this research combines White Stone Legend and the battle between the two ethnic groups to create a story for this research. Next, researchers sought for possible mathematical concepts embedded in this cultural context and developed mathematical problems within
the context. Then following this situation, they painted picture book on paper and finally produced multifunctional electronic book with animation, voice, and interaction, which is suggestive for future design and mathematical electronic media for indigenous people. Moreover, on the way of execution of this research, we faced several “problems” during the development of the electronic picture book, such as difficulty in cultural data access, incapability of combining high-level mathematical concepts, and no differentiation between mathematical problems that we created and those already in textbooks, etc. However, making good use of connection and interaction and reflection by the peers finally ended the predicament in the developmental process, and resulted in satisfaction of the participants. These problem analysis and new action projects can be crucial references for electronic picture book integrating indigenous culture and mathematical concepts in the future.

Although mathematical picture book integrated with indigenous culture produced in this research gets recognition of the tribe teachers, deeply experiencing and understanding indigenous culture is important and inevitable challenge for Han Chinese designers. To conquer this challenge, the researchers suggest gathering more cultural data and seeking consultation from seniors, organizations and staff related to Council of Indigenous Peoples, which improved the development process of electronic picture book. Of course, evaluation tools designed by teachers for electronic book related mathematical concepts is also an important factor to affect teachers’ willingness of using such an outcome. The researchers also recommend performing pretest and posttest design evaluation and believe that teachers will be more willing to teach with electronic picture books.

6. References