

An Effective Multimedia Education Platform on Tuberculosis Prevention for Taiwan Indigenous Children Based on Cloud Computing Technology

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Abstract

Schooling in a remote mountain area is a challenging issue because of the lack of teachers and technological resources. To overcome these challenges, a multimedia e-learning platform based on cloud computing technology was established. Our on-line multimedia contexts were in seven different languages, including mandarin Chinese. It is used for tuberculosis prevention education. Our platform can be easily accessed by individual teachers or students. 310 users had used the on-line platform. Furthermore, the multimedia films had been viewed by 901 users. To evaluate the effectiveness of the platform, an interactive assessment was imbedded. Also, the culturally inclusive content were tested off-line for its effectiveness by comparing learners' scores from pre- and post-course exams. Our results suggested that the culturally inclusive multimedia content is effective and the cloud computing educational platform is an effective solution for Taiwan indigenous children in remote mountain areas.

Keywords: *Education, E-learning, Health science, Indigenous culture, Tuberculosis,*

1. Introduction

Health science education can improve personal skill in disease prevention and in maintaining a healthy community. However, few successful health science education models have been demonstrated to be effective in sensitive populations such as indigenous peoples. Also, there are few successful educational programs in tuberculosis even though over 14 million persons are estimated to have tuberculosis (TB). Moreover, TB has been the leading contagious disease in Taiwan. The Council of Indigenous Peoples and the Ministry of Health of Taiwan published that crudely the TB mortality was ranked sixth for indigenous children aged 1 to 14 years in indigenous townships [1, 2]. Moreover, health disparity of TB in indigenous children exists, since there are children dying from TB in non-indigenous populations, and the disease is not ranked in the top 20 leading causes of death for all children in the same age range.

The Permanent Forum on Indigenous Issues, which was established by the United Nations in the Global Indigenous STOP-TB Expert Meeting in 2009, demonstrated numerous obstacles in identifying and treating TB in indigenous populations, such as the shortage of medical resources, lack of knowledge, poverty, and culture differences. Hence, these risk factors make indigenous people easily susceptible to TB3 [3]. To overcome the lack of knowledge about TB, it is important to develop an effective educational program that deals with TB prevention for the Taiwan indigenous population, especially the children. However, indigenous schools are in remote mountain areas, and they often do not have teachers specialized in health education. Moreover, the number of teachers who are proficient in the indigenous language is small.

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Therefore, we have developed an on-line multimedia educational platform on TB prevention for the Taiwan indigenous children. Our platform is at: <http://210.61.2.8/health/>.

2. Concept, Model and Methodology

2.1. Culturally inclusive multimedia teaching materials of TB based on multimedia theory

We have developed the multimedia content based on culturally inclusive pedagogy. Culturally responsive teaching curricula emphasize the different learning styles of students [3]. Culturally responsive teaching responds to the students' ethnicities, cultures, and languages. Teachers who use proper educational materials address different cultural backgrounds to build learning scaffolds for students [3]. One conclusion from the Global Indigenous STOP-TB Expert Meeting of the United Nations suggested that the educational contents of TB for indigenous populations should reflect the prospective indigenous people's cultural values, traditions, and lifestyles. A few studies have demonstrated that culturally responsive teaching can efficiently improve indigenous children's learning effectiveness [4, 5]. Cultural cognition and related student knowledge can be improved simultaneously using specific science topics to integrate traditional indigenous life experience into Western knowledge systems [6].

"Multimedia learning" means learning from multiple representations of the same material, including visual and verbal explanations [7, 8]. Multimedia learning can assist learners in constructing knowledge by following the following three information processes [7, 8]:

- a) The learner actively *selects* and connects relevant pieces of visual and verbal knowledge from the presented material, and stores those pieces into visual and verbal short-term memories.
- b) The learner *organizes* those selected pieces into a coherent representation, thus "organizing the selected information in short-term memory into a coherent whole." The coherent mental representation is called the situation model, which is divided into two types: visually based and verbally based.
- c) After constructing two models, the learner finally *integrates* those representations to develop both visual and verbal connections.

Furthermore, based on Paivio's dual coding theory [9], learners process the information of multimedia learning to divide two pathways: processing visual explanation and processing verbal explanation. Based on these theories, multimedia educational programs using words and images simultaneously are more effective than doing so separately. The modality of presenting words as narration is better than that of presenting on-screen text. Therefore, we applied these theories when developing our TB multimedia educational materials for indigenous children of Grades 7 to 9. The characteristics of the seven indigenous cultures were included (for the main characters of Paiwan, one of the tribal groups is shown in Figure 1).

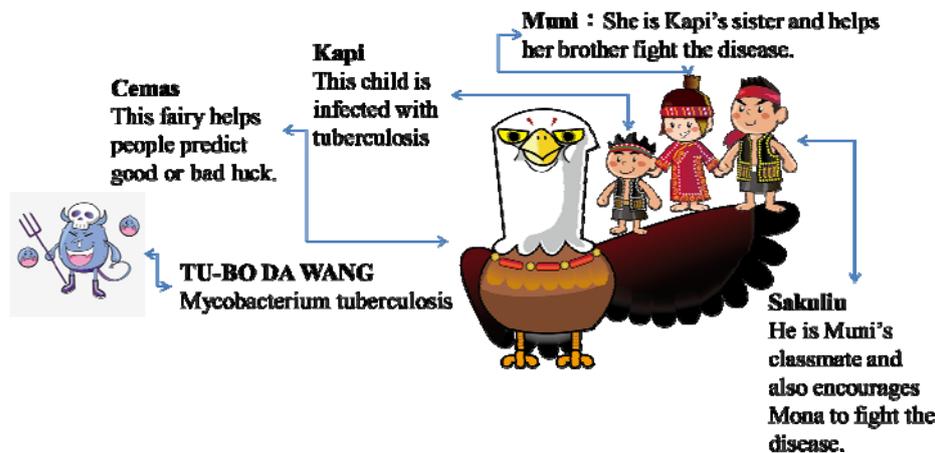


Figure 1. The main characters based on Paiwan culture context.

Regarding the script for the animated material, we designed the main characters to be interactive by including questions and answers that encourage participation. There are three main roles who are Kapi, Muni, and Sakuliu, a fairy character named Cemasa (Eagle, in the Paiwan legend, who always protects the Paiwan tribes), and a sacrifice (*Maleveq*, who prays to the ancestral spirits to bless the tribal safety), as shown in Figure 1.

Afterward, each production step was reviewed by experts in the fields of public health, education, and psychology, as well as the tribal elders familiar with the Paiwan culture and language. The websites with the animation are as follows:

“Warriors vs. Tu-Bo Da Wang” (Paiwan language version)

<https://www.youtube.com/watch?v=pjyx-uzJ2YU> (the viewer count in 5/18/2014: 387)

“Warriors vs. Tu-Bo Da Wang” (Chinese language version)

<https://www.youtube.com/watch?v=5htHz8QE2o0> (the viewer count in 5/18/2014:2849)

2.2. Community participatory education with local indigenous tribal teachers

Since the availability of qualified health science teaching is low in the remote areas, we recruited tribal villagers to participate as the seed teachers. Suitable seed teachers were required to be familiar with the local Paiwan language. The established qualification criteria included retired health teachers who had graduated from departments of nursing, public health, or social welfare, indigenous language teachers who possessed a government-provided certificate or DOTS workers who were serving or had served as a priority. The NGOs, the Health Tribe Construction Centers also assisted in the training courses of the seed teachers. After training and practice, potential seed teachers were examined by an evaluation team composed of relevant scholars and tribal elders familiar with the tribal languages and cultures. Consequently, following review, qualified persons became the seed teachers of this course.

2.3. Outcome assessment of culturally inclusive media films with pre- and post-course exams

- Research ethics: The proposal of the work was sent to Internal Review Board (IRB) prior to execution of the project in indigenous villages. In addition, town meetings were called before initiating the science educational class on TB.
- Participants: 127 indigenous Paiwanese junior high students from grade 7-9 (12-15 years old) in Ping-Tung County participated in our science class on TB.
- A multimedia education film: “The Warrior Flights with the King of TB” was produced by a professional film company. However, the script of the film was designed based on our previous study,

assessing the proficiency on the TB within indigenous villages. The content of the film has four topics: 1) general knowledge of TB, 2) identification of TB symptoms, 3) key knowledge about TB treatment, and 4) myths about TB disease in traditional cultures that were learning index to set for the evaluation purpose.

d) Proficiency evaluation test: An impacted-based written evaluation test was conducted to evaluate the effectiveness of the multimedia educational tools. The test was reviewed by five experts. A pilot test was conducted with 78 students in schools similar to the target schools, but in different villages. After this some of the questions were reframed as appropriate. There were 11 questions in the final test.

Meanwhile, the animation was dubbed in two languages.

e) Satisfaction evaluation questionnaire: A process-based questionnaire was set up to evaluate if the students liked the film. The satisfaction questionnaire was based on a Likert-type five-point scale scoring system. There were 14 questions in the questionnaire.

f) Data analysis: Paired Student's t-tests and Independent T-tests were applied for the statistics analysis.

2.4. Construction of a multimedia educational platform with cloud computing technology

a) Cloud technology for education

Cloud computing is the evolution of distributed computing and grid computing [10]. The great computing system can be partitioned into multiple independent virtual machines, and as many physical servers. The cloud computing service is convenient for people without the experience of setting up the server to build internet service, e.g., platform. It is also easy to quickly regulate the computing ability and build a service anytime [11]. Meanwhile, transferring the E-learning system into the cloud will save the cost of building and maintaining the classroom [12]. We have used Platform as a service (PaaS) [10] to build up our education platform, the "Warriors vs. Tu-Bo Da Wang" on the Hicloud service provided by the Chunghwa Telecom, a local internet service provider.

b) User interface

We developed an interactive learning environment by using Hypertext Preprocessor (PHP) language in the cloud server. The data obtained from the analyses are stored in a MySQL relational database and the webpage interface was built by PHP language. The schema for the user interface of the platform was shown in Figure 2 and separated into two parts: one is the indigenous culturally inclusive TB education interface and the other is linkages of outside websites.

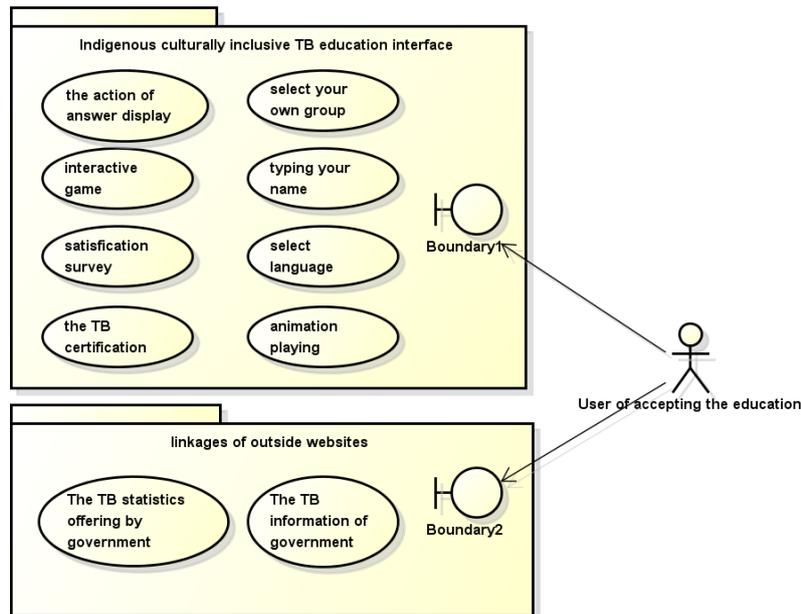


Figure 2. The schema for the user interface of “Warriors vs. Tu-Bo Da Wang” platform

c) Platform workflow

The learning workflow of TB knowledge was designed and shown in Figure 3. First, the user of accepting this education should select her own ethnic group and then enter the name. The learner can start the multimedia animation by selecting his/her tribal language or mandarin Chinese. After finishing watching the film, the system automatically goes to an interactive evaluation system, with online assessment of TB knowledge. If the learner answers correctly, the system automatically goes on to the next question. If not, the correct answer is shown on the screen and then the system automatically goes on to the next question. After completing the evaluation game, the system gives out a certification online to reward the learner. The certificate can also be printed out for the learners to keep.

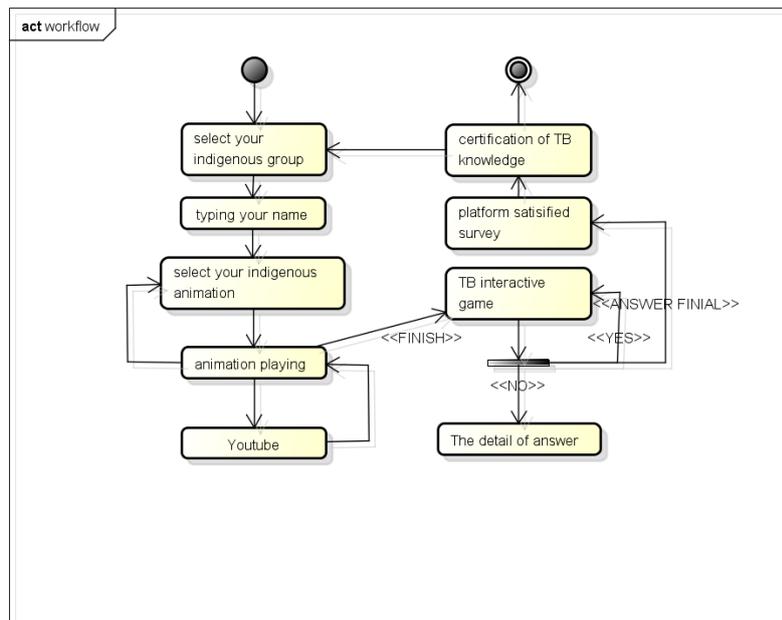


Figure 3. The schema of workflow of the “Warriors vs. Tu-Bo Da Wang” platform

3. Experiment, Simulation and/or Analysis

3.1. Outcome assessment of culturally inclusive films by pre- and post- course exams

To evaluate the outcome of the culturally inclusive TB educational program, we developed an evaluation tool based on four major TB topics. The assessment questionnaire can be divided into four major topics: general knowledge of TB, identification of TB symptoms, key knowledge about TB treatment, and the myths about TB disease in traditional cultures. Table 1 summarizes the outcome of the educational program. Before the course began, the average scores were set as baselines of 40.3 ± 19.6 for all of the Paiwan students and, for the respective different implanting year, 44.1 ± 15.6 for the first year, 35.0 ± 23.2 for the year after next. After completion of the course, the average scores increased by 32.3 ± 23.4 for all of the Paiwan students and, for the respective different implanting year, 31.1 ± 24.6 for the first year, and 33.9 ± 21.7 for the year after next respectively. All of the increases in scores were statistically significant (p values ranging from .000 to ***). In comparing between implementing first year and the year after next, the increases were not significantly different by using independent T-test. Therefore, with the same curriculum being implemented, the same townships during? two different implementing years still has significant learning effect.

We proved this course to have a highly significant learning effect on improving the understanding of TB among indigenous students from Grades 7 to 9. The assessment results indicated that the students from implementing first year and the year after next improved significantly in all four topics (***). Independent T-tests showed no significant relationship ($p > .05$) for different genders. In other words, this Paiwan culturally inclusive curriculum of TB can be provided to all indigenous Paiwan students irrespective of gender.

Table 1. Results of tribal indigenous students from Grades 7 to 9 under different teaching versions

| Score / items | Total (100) | The general knowledge of TB (4/18*100) | the identification of TB symptoms (4/18*100) | the key knowledge about TB treatment (7/18*100) | the myths of TB disease in the traditional culture (3/18*100) |
|---------------------------------|-------------|--|--|---|---|
| Total(115 persons) | | | | | |
| | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD |
| Pretest | 40.3±19.6 | 7.8±5.1 | 10.0±6.4 | 15.7±9.0 | 6.9±5.3 |
| Posttest | 72.6±20.0 | 14.8±6.0 | 18.0±6.0 | 27.1±8.5 | 12.9±4.6 |
| Degree of advancement | 32.3±23.4 | 7.0±7.4 | 8.0±7.4 | 11.4±12.0 | 6.0±5.9 |
| <i>p</i> value ^a | *** | *** | *** | *** | *** |
| First year(67 persons) | | | | | |
| Pretest | 44.1±15.6 | 8.5±5.0 | 11.4±6.0 | 17.2±8.0 | 7.0±4.6 |
| Posttest | 75.2±20.3 | 17.1±5.1 | 18.7±5.7 | 27.2±9.1 | 13.1±4.4 |
| Degree of advancement | 31.1±24.6 | 8.6±7.3 | 7.2±7.7 | 10.0±12.7 | 6.1±5.7 |
| <i>p</i> value ^a | *** | *** | *** | *** | *** |
| The year after next(48 persons) | | | | | |
| Pretest | 35.0±23.2 | 6.9±5.2 | 7.9±6.5 | 13.4±9.8 | 6.7±6.3 |
| Posttest | 68.9±19.1 | 11.7±5.8 | 17.0±6.5 | 26.7±7.8 | 12.6±4.8 |
| Increases in score | 33.9±21.7 | 4.7±7.0 | 9.1±6.8 | 13.5±10.6 | 5.9±6.2 |
| <i>p</i> value ^a | *** | *** | *** | *** | *** |

^a(**p*<0.05, ***p*<0.01, ****p*<0.001)

3.2. Process assessment of culturally inclusive multimedia content

To evaluate the process of the culturally inclusive TB educational program, we developed an evaluation tool with three major TB topics (see Method and Research Materials, “Development of the assessment tools”). Table 2 summarizes the impact of the educational program.

The average overall scores of student satisfaction with the courses in the Paiwan versions was 4.48±.58. In addition, the average score of student satisfaction of the two implementing years were 4.52±.53 and 4.44±.63. The total score was 5. Comparing between of them, the course satisfied scores were all substantially high. The questionnaires on course satisfaction were divided into three sections: course design (with an overall score of 4.54±.61), teaching style of the seed teacher (with an overall score of 4.52±.61), and learning effectiveness (with an overall score of 4.45±.73). Satisfaction was also extremely high for all three sections. Comparing between the first year and the year after next, there were no significant difference of satisfactions for overall and three divided sections. In summary, the multimedia teaching materials for Paiwan cultures were well accepted by the Paiwan students of Grade 7 to 9.

Table 2. Satisfaction analysis results of Paiwan students from Grades 7 to 9 under different implementing year

| 5 points of each question ^a / item(persons) | Total | Course design | Seed teacher’s teaching style | Learning effectiveness |
|--|-----------|---------------|-------------------------------|------------------------|
| | Mean ± SD | Mean ± SD | Mean ± SD | Mean ± SD |
| Total(115) | 4.48±.58 | 4.54±.61 | 4.52±.61 | 4.45±.73 |
| First year (67) | 4.52±.53 | 4.54±.60 | 4.57±.57 | 4.48±.64 |
| The year after next (48) | 4.44±.63 | 4.53±.62 | 4.45±.65 | 4.40±.83 |

^a5points:Strongly satisfied, 4points:Satisfied, 3points:Neither satisfied nor dissatisfied, 2points:Dissatisfied, 1points: Strongly dissatisfied

3.3. A viewer analysis of the on-line multimedia platform

After validating the culturally inclusive multimedia, we have set up an on-line educational platform with cloud technology. The on-line education session is started by a user typing his/her name and selecting a version of the multimedia film, with one of the tribal languages or Chinese (see Figure 4). The viewing time is about 20 minutes. After viewing the film, the session automatically enters into an interactive evaluation during which the user is tested for his/her knowledge about TB (see Figure 5). If the user had entered a wrong answer, an on-line correct answer would show up on the screen, which could enhance the efficiency of learning by giving out the correct answer immediately. For a period of about one year, we had analyzed the distribution of the user tribal culture background (shown in Table 3). Amis and Tayal groups have higher viewer numbers, since we had asked some of the health promotion centers in the Tayal tribe to participate and the Amis group is the largest tribal group. The results suggested that community participation via health promotion centers is an effective approach to promote the awareness in the mass.



Figure4. The Paiwan culturally inclusive multimedia film with the dubbings of Paiwan and Chinese



Figure 5. The user interface for the online interactive evaluation system

Table3. The distribution of user’s trial background

| Tribal Groups | Amis | Bunun | Paiwan | Seediq | Tayal | Truku |
|--------------------|------|-------|--------|--------|-------|-------|
| Numbers of viewers | 111 | 16 | 25 | 29 | 117 | 12 |

3.4. Outcome assessment of platform with imbedded questions

In order to assess if the on-line platform was effective, we imbedded a set of 11 questions. They are listed in Table 4. For the interactive brief section, a question-and-answer game was incorporated to strengthen the participants' impression of the course, in addition to the animation used as teaching material. The purpose of producing the interactive brief was to have the trained seed teachers, after showing the animation, engage the students with question-and-answer games to interact and collaboratively reflect on the materials, and to embed TB knowledge into them and help them re-evaluate their misconceptions of TB. Based on four topic constructions of the teaching materials, 11 questions were designed for presentation (Table 4). The teachers could share more related experiences and allow the learners to interact with one another.

Furthermore, the trained and certificated indigenous seed teachers familiar with the local indigenous languages used the teaching materials and led the students to course completion.

Table 4. The items in the interactive brief

| Questions: | Four Topic Constructions ^a |
|---|---------------------------------------|
| 1. Can all TB patients infect others with this disease? | 1 |
| 2. Is coughing for more than three weeks consecutively considered a symptom of TB? | 2 |
| 3. When TB symptoms disappear, is there any need to take TB medication? | 3 |
| 4. Can TB be caused by smoking excessively or excessive alcohol consumption? | 1 |
| 5. Are DOTS workers good helpers for caring TB patients? | 3 |
| 6. Is it easy to contract TB through aerosol droplets from infectious TB patients? | 1 |
| 7. Must people who come in contact with TB take contact examination to protect themselves and patients? | 3 |
| 8. In order to encourage the indigenous population to receive treatment for TB, are small incentive bonuses given to them after they are cured? | 3 |
| 9. Can herbal medicines commonly used in tribes or referred to in legends cure TB effectively? | 4 |
| 10. Will people who come into contact with TB patients communicate the disease to others if they test positive for tuberculin during contact examination? | 3 |
| 11. Should TB patients who are still under treatment avoid attending tribal rituals as a way of demonstrating their love towards other people in the tribe? | 4 |

^a The four topics of the general knowledge of TB are as described: 1. The topic on the identification of TB symptoms, 2. The topic on the important information about TB treatment, 3. The topic of the myths of TB disease indicates 4.?

In Table 5 the analysis on the percentage of correct answers from the users is shown. After viewing the film, for each question, the percentages of users with correct answers were all higher than 60%, except for the first question (Can all TB patients infect others with this disease?).

Table5. The analysis on the percentage of correct answers about the interactive brief from the users

| Question number | Total participants | Participants answered correctly | Percentage of correct answer |
|-----------------|--------------------|---------------------------------|------------------------------|
| 1 | 32 | 19 | 59% |
| 2 | 26 | 19 | 73% |
| 3 | 28 | 19 | 68% |
| 4 | 28 | 18 | 64% |
| 5 | 22 | 15 | 68% |

| | | | |
|----|-----|----|-----|
| 6 | 26s | 18 | 69% |
| 7 | 28 | 20 | 71% |
| 8 | 23 | 16 | 70% |
| 9 | 22 | 15 | 68% |
| 10 | 24 | 15 | 63% |
| 11 | 28 | 20 | 71% |

4. Conclusions

We have proved our designed on the workflow of the course and the content of the multimedia film are very effective in improving the understanding of TB knowledge among indigenous students from Grades 7 to 9. Independent T-tests showed no significant relationship ($p > .05$) for different genders. In other words, this Paiwan culturally inclusive curriculum of TB can be provided to all indigenous Paiwan students irrespective of gender.

5. Acknowledgements

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