Presented at the DLSU Research Congress 2016
De La Salle University, Manila, Philippines
March 7-9, 2016

Development of a Teachware on Earthquakes and Typhoons for Grade 8

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Abstract: This paper covers the development of a multimedia Teachware to improve teaching Earthquakes and Typhoons of La Salle Green Hills (LSGH) Grade 8 Science teachers. The proponents underwent data collection, research, and content expert consultation in order to determine what exactly the problems in teaching these two topics. Problems identified included (a) difficulty illustrating the processes that happen simultaneously during earthquakes and typhoons (b) difficulty in simulating how different variables affect earthquakes and typhoons and (c) difficulty simulating scenarios of how earthquakes and typhoons are experienced in real life. The development methodology used the ADDIE Model that divides the entire development work into Analysis, Design, Development, Implementation and Evaluation stages.

The design of the Teachware followed a theoretical framework that used the following theories to determine the media and content presentation to solve the teaching problems - Elaboration theory, Meaningful Reception Learning Theory and Merrill's 1st Principles of Instruction. The topics covered by the Teachware have both vertical and horizontal relationships to each other. Elaboration theory will use the zooming in and zooming out function for the vertical relationships. Meaningful Reception Learning Theory, specifically, Combinatorial Learning will be used for the horizontal relationships. Finally, Merrill's 1st Principles of Instruction, specifically the Demonstration Principle will be used to address the visualizations and comparisons of processes.

At the end of the development, effectivity of implementing the media and content following the theories to address the problems were assessed and evaluated by having the Teachware used by teachers. An assessment and evaluation survey developed composed of criteria on areas of media and content, measuring the effectiveness of presentation and the accomplishment of the instructional objectives the Teachware was anchored on

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Key Words: Teachware; Multimedia; Earthquakes and Typhoons; Instructional Technology

1. INTRODUCTION

Earthquakes and Typhoons are natural disasters that happen in many parts of the world, especially in the Philippines which lies within the boundaries of the Pacific Ring of Fire and a zone where many tropical storms happen (about an average of 19 storms per year), (Cordero-Navaza, Darvin-Faraon, Religoso & Vengco, 2014). It is important to learn about these natural disasters because they happen very often in the Philippines. Earthquakes occur so many times in a day that it cannot be counted by hand, as most of them are so small and weak that they are not easily felt or detected by ordinary people. Typhoons on the other hand show much more obvious signs when it hits a specific area in the country. Strong earthquakes bring about much destruction and property damage in the area where it happens; so do typhoons because they bring in strong winds and heavy rainfall over a large area, which can lead to floods. As reported by Bloomberg "The Asian Development bank estimates that losses from typhoons and earthquakes in the Philippines average $1.6 billion annually, the highest in Southeast Asia" (Buhayer, 2013).

With the recent adoption of the K-12 curriculum in the Philippines, it was made clear what science education aims to accomplish: "Science education aims to develop scientific literacy among students that will prepare them to be informed and participative citizens who are able to make judgments and decisions regarding applications of scientific knowledge that may have social, health, or environmental impacts."

In a typical school setting the teacher tries to find creative ways to visualize to the class what happens during an earthquake or typhoon but these are not enough for the learners. An example of a creative visualization may be through the use objects around the classroom, the use of a map or globe or even drawing on the blackboard. The teacher sometimes even makes up analogies to help the students to grasp the concepts. Below is a listing of classroom activities implemented which visualizes earthquakes in a creative manner:

1. Experiments such as using a hard-boiled egg and comparing it with the layers of the earth
2. Using a piece of pad paper or towel to show the process of stress by pushing and pulling on the ends of these objects.
3. If the classroom has a map with the pieces of each continent (like a puzzle) this can help to visualize the movement of tectonic plates.
4. Modelling how fault lines are formed in paper using bond paper, colored pens, scissors and cardboard strips.
5. Snapping a wooden stick in half to demonstrate the sudden snapping point where stress builds up between plates in an earthquake

And for typhoons:

6. The movement of hot and cold (differently colored) water is mixed to demonstrate the sinking of cold air and rising of warm air
7. The water cycle experiment using a large, glass bottle or jar half filled with water. Then covered with a lid and placed in a sunny area. to show the evaporation of water
8. Using a spinning plate and a marble to demonstrate the Coriolis Effect.

Even with these approaches at hand the students may still end up not getting the essence or concepts of how earthquakes and typhoons work so they end up with a limited understanding about the topic matter because of the ineffectiveness of current teaching materials and the macroscopic nature of earthquakes and typhoons

2. STATEMENT OF THE PROBLEM

Through interviews, class observations and discussions with teachers teaching the topic of earthquake and typhoons, the following problems were identified.

- The teacher has difficulty illustrating the processes that happen simultaneously during earthquakes and typhoons
- The teacher has a difficulty in simulating how different variables affect earthquakes and typhoons

ISSN 2449-3309

- The teacher has difficulty simulating scenarios of how earthquakes and typhoons are experienced in real life

3. METHODOLOGY

The development methodology used the ADDIE Model that divides the entire development work into Analysis, Design, Development, Implementation and Evaluation stages. During the analysis stage, several activities were conducted to include:

- Documenting the current learning situation
- Documenting assumptions of prior knowledge
- Problem identification through observation, interview and discussion with teachers
- Content Analysis

During the Design stage, several activities were conducted in order to conceptualize a solution to address the problems identified, these include:

- Development of Theoretical Framework
- Multimedia Selection
- Development of Instructional Design Matrix
- Storyboarding

During the Development and Implementation stage, the following activities were performed to actuate the design into an actual instructional software:

- Screen Design and Development (some resulting screens could be found in figure 2.0 to 5.0)
- Scripting
- Development Technical Media Specifications
- Prototype Development

At the end of the development of the teachware, several iterations of assessment through actual demonstration and use of the teachware was conducted and the acceptability of the actual product is evaluated by the teachers through a survey.

4. RESULTS AND DISCUSSION

Theoretical Framework

For the entirety of the teachware, the theoretical framework (see figure 1.0) presented above will be implemented. The framework will use the following theories to determine the media and presentation to solve the teaching problems previously discussed: Elaboration theory, Meaningful Reception Learning Theory and Merrill's 1st Principles of Instruction. The topics at hand have both vertical and horizontal relationships to each other. Elaboration theory will use the zooming in and zooming out function for the vertical relationships. Meaningful Reception Learning Theory, specifically, Combinatorial Learning will be used for the horizontal relationships. Finally, Merrill's 1st Principles of Instruction, specifically the Demonstration Principle will be used to address the visualizations and comparisons of processes.

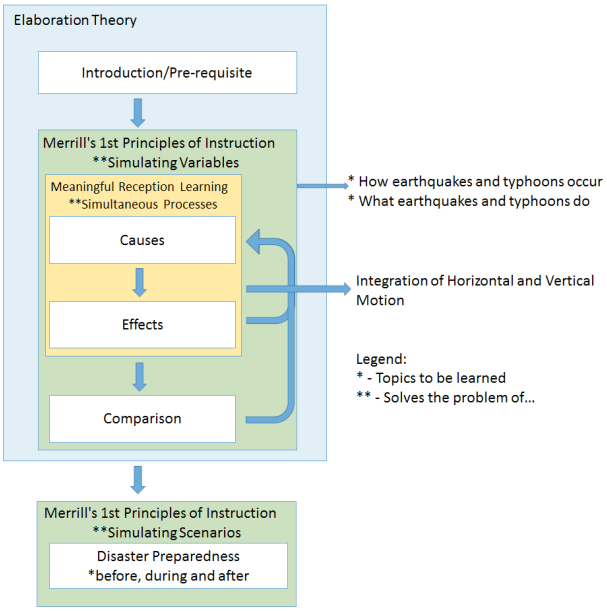

Fig 1. Theoretical Framework

Elaboration theory is an organizational theory, it states that content should be organized in a way that it is learned from simple to complex, from macro to micro. The simplest version of a concept should be taught first, then eventually the topic is narrowed down and the details will be elaborated. The idea behind it is that once the learner has a general understanding of a concept, when the specific details are being presented, the student will be able to relate that to the previous concepts, reinforcing his knowledge (Reigeluth, 1983).

Reigeluth (1983) makes an analogy of the Elaboration theory with a zoom lens. The theory is like looking at a wide-angle image. A person looks at the whole image and sees the different parts and their relationships, but not in a detailed level. The person then zooms in to a portion of the image to analyze a specific sub-part. After studying the sub-part, he then zooms out and moves on to another sub-

ISSN 2449-3309

part and studies it. Eventually, the person will start to see and realize the interrelationships between the subparts and gain a greater understanding of the whole image.

Result of Content Organization

Together with the content expert, the following is a sample result of re-organization of the content following the Elaboration Theory:

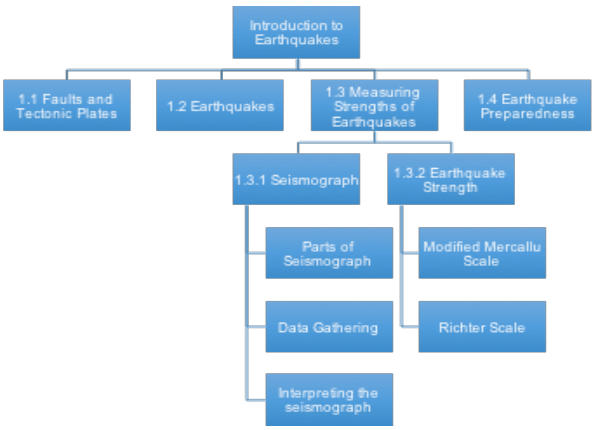

Fig 2. Sample re-organization following the Elaboration Theory

Merrill's 1st Principles of Instruction is an instructional theory created by David Merrill. This theory consists of five principles: problem-centered, activation, demonstration, application and integration. According to the demonstration principle, it states that learning should be demonstrated or shown, not told. The demonstration should be aligned with the learning objectives, like examples and non-examples for concepts, demonstrations and visualizations for procedures and processes, and modeling for behavior. Learners should also be guided accordingly. Relevant information should be directed to the learner appropriately and they should be presented in several ways and compared. (Merrill, D., 2002).

Lastly, demonstrations should have relevant media integrated into them. Different types of media should not compete, but to be complementary of one another. Some principles are mentioned such as both words and graphics can be close together as long as they have a purpose and correspond; presenting words with simultaneous audio narration may interfere with learning (Merrill, D., 2009).

The problem of teaching simultaneous processes will be solved by Elaboration Theory as well as the Meaningful Reception Learning Theory, particularly, the 4th learning process which is Combinatorial Learning. Elaboration Theory will handle the organization of the vertical relationships of the topics. The teachware will use the zooming in and zooming out analogy to handle the vertical relationship of the topics while combinatorial learning will handle the horizontal relationship of the topics. Additionally, the teachware will use some of the major strategy components of Elaboration Theory namely: elaborative sequence, learning-prerequisite, analogy, cognitive-strategy activator (embedded and detached), and learner control. The lessons will follow a simple to complex organizational structure (elaborative sequence, learning prerequisite). Elaboration Theory says that topics that are hierarchically arranged in a vertical manner should be learned from a simple to complex manner, wherein the first/top-most topics should be taught first before the topics below it in order to fully understand what is being taught. The zooming in and zooming out analogy is used as a way to traverse the topics. An example would be causes of earthquakes. The causes of earthquakes are tectonic plates, faults and their movement, this will then lead to what earthquakes are, which will then lead to the topic about the strength of these earthquakes and how they are measured. Combinatorial Learning states that while a topic can be made up of smaller topics, it is imperative to learn how these smaller topics are related to each other as well as how these small topics relate to the bigger topic. An example of a horizontal relationship is the formation of typhoons, wind and water may not be directly related to each other and they are neither higher nor lower in hierarchy to each other, but they are related to each other because they happen simultaneously to cause typhoons. Figure 3.0 to 6.0 are sample screenshots as a result of translating the content to media following the demonstration principle.

Evaluation and Results

The following were conducted to collect feedback from the teachware's testers regarding its effectiveness in accomplishing its teaching objectives:

- Survey – to be answered by the testers
- Teachware Testing – testers will use the teachware hands-on while the proponents observe and help when necessary

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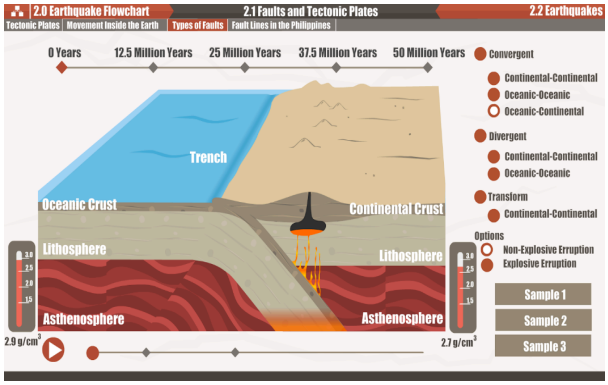

Fig 3. Types of Faults

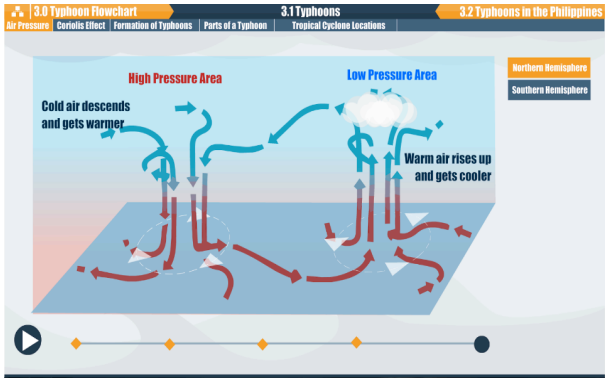

Fig 4. Air Pressure

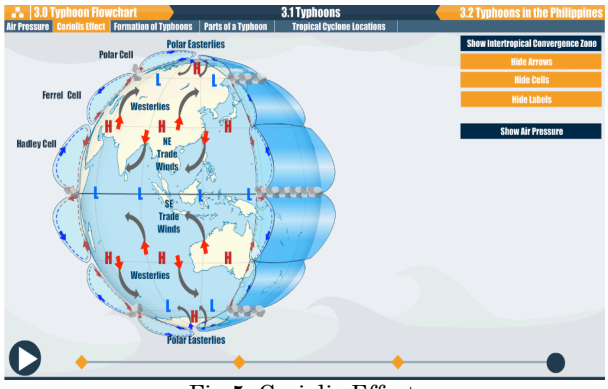

Fig 5. Coriolis Effect

Since the teachware's objectives vary per screen, it was decided that the survey questions would be separated per screen as well, although this resulted to a longer survey, this allowed for a more accurate feedback.

Based on the individual results, it appears that the effectiveness of teaching a topic, as expected, was heavily influenced by how understandable the media used was. This makes sense as results with a high/low media rating would also correlate to the content being high/low as well. Although there were some special cases where sometimes the media was lower than the content rating. These point out that it also depends on the media's importance in teaching the topic so let's say if a minor media (e.g. a show/hide label button) was considered ineffective, it does not necessarily point out that teaching the topic(content) would be ineffective or pulled down as well. Also, the importance of media varies per topic so a show/hide label button might be considered minor to some while it is major to other topics. This is the reason why contents were often still seen as effective despite having some media considered ineffective.

According to summary of results (see figure 6.0 to 9.0), the testers were pleased with the teachware. Not all topics were received equally, some were obviously received better than others but overall all topic implementation in the teachware were all considered effective with all ratings ranging from 3.0 to 4.0.

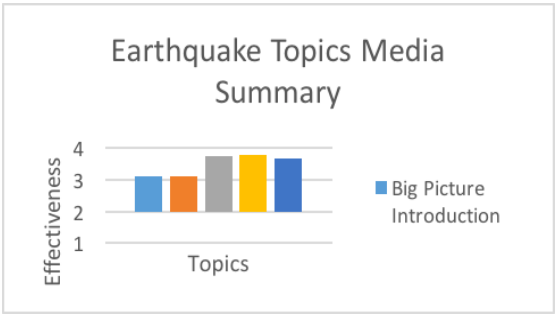

figure 6.0 Earthquake Topics Media Evaluation Summary

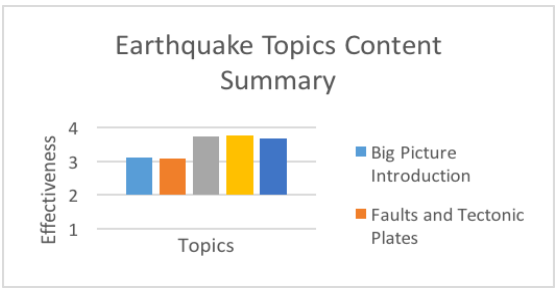

figure 7.0 Earthquake Topics Content Summary

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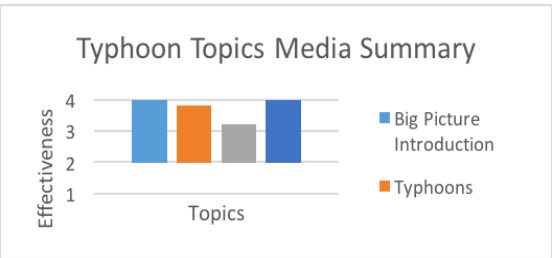

figure 8.0 Typhoon Topics Media Summary

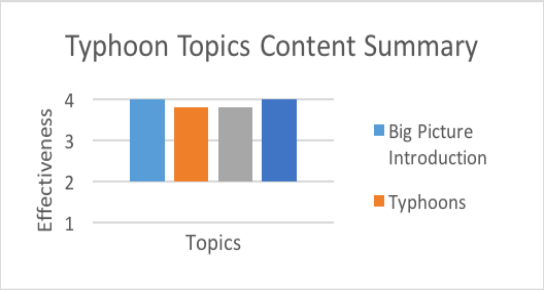

figure 9.0 Typhoon Topics Content Summary

In testing the teachware, the proponents found out how effective their developed teachware was. As seen in the testing result analysis, the teachware was considered effective overall in teaching the topics for both Earthquakes and Typhoons by the teachers (target users). Through the testing and evaluation, the proponents discovered some areas in the teachware that can be improved. However, since the testing done only involved teachers, it is unclear as to how effective the teachware would be for the students themselves (target audience). Regarding this, it is a good idea to conduct student testing for future insights of the teachware's effectiveness.

5. CONCLUSIONS

Based on the testing results, the teachware was considered effective as a teaching tool for Grade 8 LSGH Science teachers, it was well received and considered as an improvement to their existing teaching tools in Earthquakes and Typhoons. Most importantly, it was able to solve the 3 teaching problems of the teachers. The different simultaneous processes involved in both the development of Earthquakes and Typhoons were connected by presenting these processes in a coherent manner. Seeing how one process could result to different outcomes based on different variables was solved by showing the different outcomes possible in one process depending on its variables. Improving how disaster preparedness is presented was accomplished by showing different scenarios through animations showing what could happen before, during and after these disasters. To sum it all up, the teachware generally was able to accomplish its objectives, although there is a room for improvement, the proponents considers the results of the research to be positive.

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