The development of learning materials toward landslide hazards to raise awareness among upper elementary students in Uthai Thani province*

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Nattawan Tangsuk

Research Institute for Languages and Cultures of Asia, Mahidol University, Thailand

nattawan.tangsuk@gmail.com

Weeranan Damrongsakul

Faculty of Liberal Arts, Mahidol University, Thailand

weeranan2011@gmail.com

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Abstract

There are many tendencies of landslide hazards happen in Thailand which may cause high level of damage of life and properties. The landslide hazards may happen especially at Uthai Thani province where the highest risk of landslide hazards many occur cause extensive damages thus, to make a clear understanding and preparing residents of unexpected landslide hazards is a must. The learning comes from museum where number of knowledges outside classroom available and they are significant tools to create residents' understanding. The role of museum is aimed to create society contribution that will benefit everyone equally. Moreover, the museum is not only giving knowledges but to facilitate the learning process. There are not only new knowledges that given to the audiences but experiences and skills too. Hence, this research studies how to use media of landslide hazards to raise awareness for upper elementary school students (Elementary 4-6 students) in Uthai Thani Province with the consistence of 21st century learning. The learning is to let students to have direct experiences, adapt oneself to changes occur, understand together with protect oneself from landslide hazard, and propagate knowledges to others.

Keywords: museum, learning material, 21st century learning, landslide hazards

1. Introduction

The statistics of global landslide hazards from 2004 to 2016 included many countries across the world, especially Asia. Statistically, 75% of landslide hazards occurred in Asia. The number of landslide hazards occur along mountain ranges, such as Himalayas, India, including the southeastern part of China, Laos, Bangladesh, Myanmar, the southern part of Indonesian archipelago, and Philippines. This includes Thailand where landslide hazards occur often as its geography is characterized by mountain ranges. In addition, the southwest monsoon and intertropical convergence zone also cause regular rain. These are factors influencing frequent landslide hazards. (Melanie & David, 2018)

Thailand has a tendency of frequent landslide hazards, which could happen from time to time in different scales, causing loss to life and properties. According to information about landslide hazard in Thailand gathered by Department of Mineral Resources from 1988 to 2018, it was found that large-scale landslides occurred 25 times in various areas, especially in regions with high rainfall and steep slopes. The three areas with the highest losses are shown in Table 1.

Table 1 The three areas with the highest losses from landslide hazards from 1988 to 2018

Order	Location	Date	Overall Damage
1	Nakhon Si Thammarat Province and Surat Thani Province	November 22, 1988	There were 289 deaths, 9,644 houses damaged, and approximately 6,575 Rai of agricultural land damaged.
2	Phetchabun Province	August 11, 2001	There were 136 deaths, 109 injuries, 4 missing persons, 188 houses destroyed, with the estimated loss value of 645 million baht.
3	Uttaradit province, Sukhothai province, and Phrae province	May 23, 2006	There were 87 deaths, 707 entirely damaged houses, and 3,979 partly damaged houses.

In July 2016, Uthai Thani province experienced the impact of a landslide hazard due to continuous rainfall for several consecutive days in the area of Nong Chok sub-district, Ban Rai district. This event caused the soil in the mountainous area to be unable to contain the water, leading to mudslides and flash floods in sugarcane and corn fields. Over 1,000 Rai of agricultural land were damaged as a result. Moreover, the flood water combined with a large amount of soil and flooded over 10 households, leaving no time to salvage any belongings inside the houses. The incident caused all households to be completely damaged. Additionally,

roads within the village were also blocked by the flowing mud which caused the traffic to be obstructed.

In September 2021, continuous rainfall for several days in Mae Wong National Park, Nakhon Sawan province, resulted in flash flood in the area of Kok Mor sub-district, Thap Than district. Three villages were affected by the incident. The flash flood submerged houses, agricultural areas, temples, and schools, causing significant damage to properties and infrastructure.

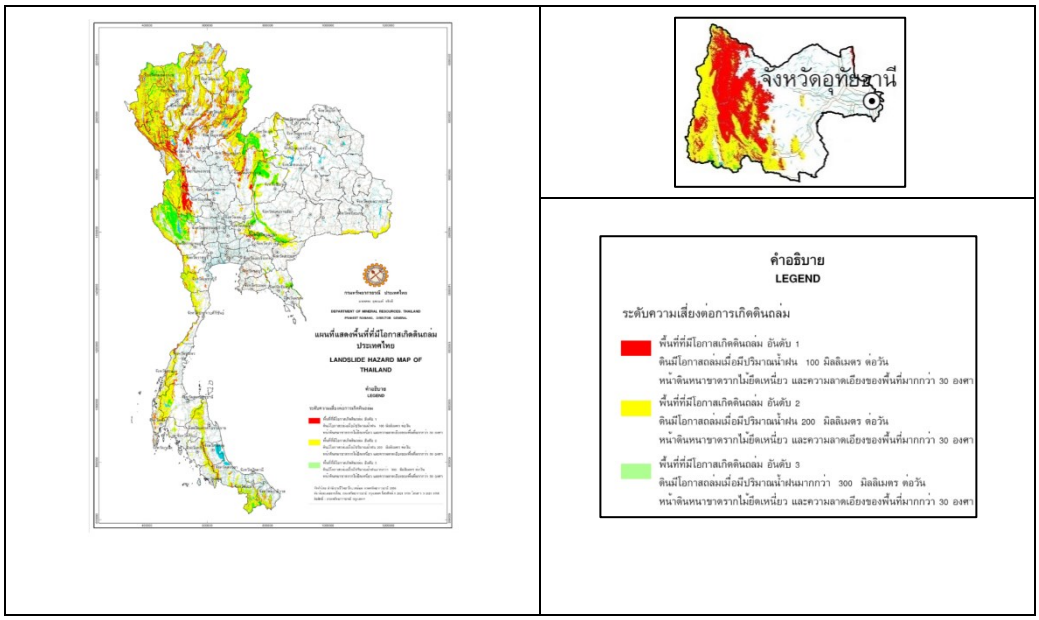

Figure 1 Map of all areas with landslide hazard risk in Thailand, specifically in Uthai Thani province.

Source: Department of Mineral Resources (2013)

Based on the information in Figure 1, Thailand has several large areas in many provinces at risk of landslide hazards, especially Uthai Thani province, which has the highest risk of large-scale landslide hazards. The soil is prone to a landslide if there are 100 millimeters of rain per day, the topsoil is thick with insufficient root anchorage, and the slope of the terrain exceeds 30 degrees. Since Uthai Thani province has a high risk of large-scale landslide hazards, it is necessary to raise awareness about the disasters among local people. Therefore, they are informed about how to prevent and prepare for potential landslide hazards.

Raising awareness about disasters among the public by providing knowledge during childhood is an approach to fostering the fundamental, especially among upper elementary students (Elementary 4-6 students), given the significant capacity for learning development within this age group. According to Sriruen Kaewkangwan (2006), this is the crucial time to

build a foundation in education, basic knowledge, and cognitive development. Children at this age develop critical thinking abilities, gain reasoning skills, and can do well in group activities. Hence, this is the most suitable time to foster knowledge about disasters to raise awareness in terms of preventing and preparing for potential landslide hazards.

This research aimed to develop learning materials toward landslide hazards to raise awareness among upper elementary students in Uthai Thani province. The objective of this research included investigating geographic characteristics and geoscientific conditions that caused landslide hazards in Uthai Thani province, the prevention of landslide hazards, and developing learning materials to raise awareness and provide practice when landslide hazards occurred for upper elementary students (Elementary 4-6 students) in Uthai Thani province. The results of the study would be guidelines to raise awareness and prepare to handle potential landslide hazards. This was the learning outside of the classroom to enhance life skills both in the present and future. Additionally, the development of learning materials that was consistent with the 21st century learning could stimulate further enhancement on critical thinking abilities, stimulate awareness among learners, and lead to knowledge sharing.

2. Concepts and Related Literature

2.1 The role of the museum

In Prague, on 24 August 2022, the Extraordinary General Assembly of International Council of Museums (ICOM) has approved the proposal for the new museum definition. The new ICOM museum definition is: “A museum is a not-for-profit, permanent institution in the service of society that researches, collects, conserves, interprets and exhibits tangible and intangible heritage. Open to the public, accessible and inclusive, museums foster diversity and sustainability. They operate and communicate ethically, professionally and with the participation of communities, offering varied experiences for education, enjoyment, reflection and knowledge sharing.” (ICOM, 2022).

The museum has 8 essential roles, both front-end and back-end, as specified by Jira Jongkon (1989) as follows: 1) Collection of artifacts, 2) Inspection duties, 3) Documenting evidence, 4) Preservation of artifacts, 5) Ensuring safety, 6) Artifact exhibition, 7) Educational provision, and 8) Social responsibilities.

Research in museums is crucial for learning development, which could be compared to non-formal education. Learners could learn whenever they like, hence it could also be called independent learning. This leads to learners being capable of creating knowledge and helps them with essential life skill development. The educational role of the museum must aim to

support the core skills of learners, which include creativity, critical thinking, information synthesis, potential for innovation, and collaborative abilities (AAM, 2015, cited in Phattharaphon Phutthong, 2015).

Non-formal education or informal education is part of lifelong learning. According to the National Education Act B.E. 2542 (1999), it was mentioned that lifelong learning is an educational management process that combines formal, non-formal, and informal education together. Lifelong learning correlates with lifestyle. It offers knowledge, skills and sufficient experience to live. Learners could be aware and adapted to the changing environment and society appropriately. Learning process management would emphasize practicing skills, critical thinking skills, management skills, confrontation skills, and applying knowledge to prevent and solve problems. There are activities for learners to learn from firsthand experience, practice in real life, be able to think and start to do, and develop continuous curiosity.

The current global education is stepping into the 21st century. Wijarn Panich (2015) has mentioned about life skills in the 21st century that subject content is important but not sufficient for learning to live in the 21st century world. Presently, learning subject content should be the exploration of the learners. Teachers should guide and design activities that help each learner assess their learning progress. Knowledge providers must adjust their approaches by aiming for lifelong learning, while knowledge acquired by learners can be transformed. The transformation results from frequent practice, self-experimentation, experiential learning, gaining firsthand experience, and gaining knowledge from diverse learning sources.

2.2 Concept of learning materials

Kemp (1989) suggested that in addition to the learning task or learning situation, which is crucial in determining the choice of media, the subsequent important consideration in selecting learning materials is the characteristics of the media. Teachers should examine the characteristics of each type of media when choosing learning materials. The characteristics of media refer to the potential of media in expression, including various features such as motion, color, and sound. The important characteristics of media include: 1) Visual representation (e.g., photographs, graphics), 2) Size factors (e.g., use/no use of projection to enlarge), 3) Color factors (e.g., various colors, black and white), 4) Motion factors (e.g., still images, moving images), 5) Language factors (e.g., text/letters, spoken words), 6) Relationship between images and sound (e.g., images with/without sound), 7) Data organization factors (e.g., presented in a sequential order or based on viewer's choice of order).

Erickson (1968, as cited in Kamon Wiasuwan, 1997) suggested the main criteria for selecting learning materials as follows: 1) Choose learning materials that align with the

learning objectives. 2) Select learning materials that align with the content characteristics of the lesson. 3) Choose learning materials suitable for the characteristics of the learners. 4) Select learning materials appropriate for the number of learners and the teaching-learning activities in each session. 5) Choose learning materials suitable for the learning environment. 6) Select learning materials that are interesting and captures attention. 7) Choose learning materials that are user-friendly for easy storage, maintenance, and usage.

2.3 Concepts of Geological Disasters

Landslide Geological Disasters refer to the flow of soil and rocks along slopes influenced by gravitational force, often occurring over a large area. The disasters leave traces of solifluction, resulting in significant loss of life and property for the affected population. Typically, landslide hazards are the result of flash floods which occur after heavy and prolonged rainfall. Meanwhile, solifluction is also caused by the flow of soil, but it occurs over a small area such as along road embarkment. The causes of landslides can be categorized into two types (Tawatchai Tingsanchali, Seree Supratid, Worakorn Mairuang, and Lursak Reutrakul, 2003): 1) Human-induced causes and 2) Natural causes. The Department of Mental Health (2005) has categorized the impacts of geological disasters as follows: 1) Impacts on individuals, including three aspects: physical, mental, and social aspects, 2) Impacts on families, including two aspects: mental and social aspects, and 3) Impacts on communities, including community structures and environmental aspects.

The effectiveness of disaster prevention in reducing both loss of life and property depends on the severity of the disasters and the community's ability to cope with them. Humans cannot prevent disasters, but what can be done is to minimize the losses. The duration of a disaster is short, but its impact is severe and causes widespread damage to both victims and those affected. Almost or most of the support providers have no knowledge and experience in dealing with such events before. (Sumol Srisuwatana, Sasitorn Theptrakanporn, Mukda Takrautthong, Nonthalee Weerachai, 2005) Therefore, providing knowledge and understanding in dealing with disaster situations will lead to efficient preparation, reducing the losses from such disasters. If there is an operation on proactive prevention and impact reduction along with comprehensive public preparation provided, it can help mitigate the severity and enhance the resilience of the population. This results in a decreased risk of disasters for various countries. For this reason, the global community supports each country worldwide in prioritizing disaster risk reduction. (Department of Disaster Prevention and Mitigation, 2013) The preparation of the population to be capable of coping with potential disasters increases the likelihood of safe lives during disasters.

3. Research Methods

This research employed mixed methods which included documentary research and quantitative research utilizing primary data.

3.1 Documentary research. The researcher gathered information on the geographical characteristics and geoscientific conditions contributing to landslides in the Uthai Thani province. The study also investigated the nature of landslides, causes of landslides, types of landslides, early warning signs before landslides, international case studies on landslide disasters, and documents about learning materials in various museums. After gathering information from document research, the information was used to produce learning materials about landslide hazards with the aim of assessing the sample group.

3.2 Quantitative research utilizing primary data. This involved experimental application of landslide hazard learning materials with the sample group. The learning materials were presented in the form of a small-scale exhibition, consisting of seven items as follows: 1) Jigsaw Puzzle, 2) Knowledge Paper Set, 3) Pop-up Book: Knowing What to Do When Faced with Landslides, 4) Landslide Song, 5) Learning with AR, 6) Landslide Simulation Experiment and 7) Enjoying Worksheets. A questionnaire was employed as a tool for data collection from the sample group by assessing before and after utilizing learning materials.

The population for this research consisted of upper elementary students (Elementary 4-6 students) within Uthai Thani province. The sample group size was determined using the Yamane formula (Yamane, 1976, as cited in Penkhae Saengkaew, 1998) based on the total of 2,729 upper elementary students in Uthai Thani province (Office of the Permanent Secretary, Ministry of Education, 2022). The sample group for this study concluded 131 students. The selection of the sample group for this research utilized a purposive sampling method. The researcher selected upper elementary students (Elementary 4-6 students) in Uthai Thani province. The schools were chosen based on their proximity to the areas of highest risk of landslide hazards, which included Huai Kha Khaeng Witthayakom School in Lan sak District, Ban Nam Phu School in Ban Rai District, Ban Khao Kwang Thong School in Nong Chang District, and Ban Klong Haeng Witthaya School in Huai Khot District.

Statistics used in data analysis included frequency, percentage, mean, standard deviation, and dependent t-test statistics.

The research period took place from August 2020 to July 2023.

4. Research results

4.1 Geographical characteristics and geoscientific conditions contributing to landslides in the Uthai Thani province and landslide hazard prevention.

According to the investigation of geographical characteristics and geoscientific conditions contributing to landslides in Uthai Thani province, it was found that the majority of the area or 2 out of 3 parts of the entire region was covered by forests and mountains. The average annual rainfall is 1,770.3 millimeters, with 105 rainy days per year. The general geoscientific characteristics of Uthai Thani province included metamorphic rock, sedimentary rock, igneous rock, and unconsolidated rock. Areas prone to landslides in Uthai Thani province included 5 districts, 18 sub-districts, and 115 villages, totaling 964,000 Rai. These areas consisted of Thap Than District, Sawang Arom District, Huai Khot District, Ban Rai District, and Lan Sak District, with a total of 106 villages at risk of landslide hazards.

Based on the study of the nature of landslides, causes of landslides, types of landslides, early warning signs before landslides, preparation before landslides, how to handle landslides, and how to cope after landslides to use the information for creating learning materials, it could be concluded as follows. Landslides commonly occur in mountainous areas with steep slopes. water was the key factor to stimulate landslides. Hence, landslides often occurred during periods of heavy rainfall. The causes of landslides can be categorized into two main factors including human-induced and natural causes. There are five types of landslides, namely falling, sliding, toppling, spreading, and flowing. Regarding the warning signs, during the moment before landslides, abnormal signs could be observed from natural occurrences, changes in constructions on the ground, and geographical characteristics of the villages at risk of landslide hazards. As for landslide preparation and response, it included assessing the risk conditions of the area, organizing surveillance duty shifts, and participating in evacuation drills. Regarding the response actions when a landslide occurred, it involved evacuating along safe routes, maintaining a distance from rivers, avoiding paths aligned with soil flow or water currents, and in case of being swept away by water, seeking large trees to hold onto and climbing to stay above water. It was also advisable to avoid driving through landslide-prone areas. Regarding how to cope after a landslide occurred, it included refraining from entering and returning from houses or structures that have been damaged by the landslide. Additionally, diversion paths for soil and water must be established.

4.2 The development of learning materials toward landslide hazards to raise awareness and ways to response among upper elementary students (elementary 4-6 students) in Uthai Thani province

The researcher gathered information from documentary research and used it to create learning materials about landslide hazards. The results of the development of learning materials toward landslide hazards to raise awareness among upper elementary students in Uthai Thani province which were consistent with the 21st century learning included learning skills, information skills, and life skills. The core concept of developing learning materials included learning, enjoying, and having awareness. Learning materials developed aimed for students to gain knowledge, develop critical thinking, enjoy, and gain awareness in disaster prevention for themselves, their families, and those around them.

4.2.1 Learning materials

The learning materials were developed to create a learning atmosphere by designing them to convey emotions and feelings in them. Most of the colors used were earth tones such as brown, green, blue, white, gray, and brick red, which were close to colors found in nature. This helped stimulate imagination about the colors in nature, such as the colors of mountains and water. Learners would receive the feeling of truly experiencing nature. The font used in creating these learning materials included Thai characters from the "SanamDeklenchaya" font and English characters from the "SanamDeklenchaya" font. The font had a playful and informal style, which added a sense of fun and friendliness. Therefore, they were suitable for the target group of learning materials. The target schools had limited space for exhibitions. They could take place in areas such as the school library or science classrooms. Therefore, the exhibition was presented on a small scale with the aim of providing educational knowledge to students. It was organized in the form of exhibition tables and was named "Landslide Hazard Awareness Tables. Additionally, because learning about landslide hazards was considered a new and rather challenging topic, especially for the target group of upper elementary school students, it was necessary to consider appropriateness in providing knowledge and to infuse fun into every learning material. The development of learning materials was done in the form of a "Hands-on Experience," which meant learners could touch and play. There was a total of 7 learning material items as follows: 1) Jigsaw Puzzle, 2) Knowledge Paper Set, 3) Pop-up Book: Knowing What to Do When Faced with Landslides, 4) Landslide Song, 5) Learning with AR, 6) Landslide Simulation Experiment and 7) Enjoying Worksheets.

1) Jigsaw was inspired by the National Discovery Museum Institute, which emphasized the importance of creating learning materials in exhibitions that integrate entertainment and

educational elements (Edutainment). This concept included various games that offer both fun and informative content, promoting mindfulness and enhancing learning potential. Jigsaw specifically focused on creating jigsaw puzzles depicting landslide scenarios that have occurred in various provinces of Thailand. The aim was to raise awareness about the damage caused by landslides and to provide visual maps of areas prone to landslides in Thailand. This was intended to help the target audience understand the landslide risks in the provinces where they resided.

2) Knowledge Paper Set consisted of three parts as follows. Pop-up Paper Set, learning about the dangers and causes of landslides. Interactive Paper Set, learning about the characteristics of various types of landslides. And Slide Paper Set, learning how to survey the area around one's home to determine if it is at risk of landslides. These paper sets were designed to be easy to make from paper and were cost-effective learning materials.

3) Pop-up Book: Knowing What to Do When Faced with Landslides is a three-dimensional learning experience. It was a simple material but incorporated fun and excitement for students, featuring colorful illustrations, cartoon characters, and attractive visuals. Additionally, students could borrow the book to study further at home. This book covered essential topics related to landslide preparedness. It included content on recognizing landslide warning signs, preparing for and responding to landslides, as well as post-landslide actions.

4) Landslide Song contained lyrics related to how to recognize warning signs before a landslide occurs and how to escape to safety. The concept was about cultivating learning through music. Songpot Supaphol (2014) referred to research from the Psychology Department at Washington University. This research suggests that humans can train their brains to memorize and recall various things quickly through learning that involves associating memories with musical rhythms. In addition, there is also the traditional lullaby called "Smong," which is a song used to soothe the children of the Simeulue Island in Indonesia. The Simeulue Islanders have been affected by tsunamis since as early as 1907 (Widianto, 2018). The lyrics of the song revolve around recognizing tsunamis and survival techniques. During the major earthquake and tsunami in 2004, the tsunamis devastated Simeulue Island. However, the islanders were able to evacuate promptly and correctly, despite the island being located just 60 kilometers away from the epicenter of the earthquake. It was observed that only six people from Simeulue Island lost their lives. This highlights how the practice of embedding survival knowledge into lullabies helped the community effectively survive disasters.

5) Learning with Augmented Reality (AR) involved overlaying digital graphics onto each page of a book. In the "Pop-up Book: Knowing What to Do When Faced with

Landslides," a cartoon boy served as the main character guiding the story. Users could easily interact by scanning QR codes on each page of the book using a smartphone or other electronic devices. Once scanned, animated images of the cartoon boy would appear and narrate the content of each page. Currently, learning materials increasingly incorporate technology as a tool to aid learning, aligning with the needs of 21st-century learning, which emphasizes the integration of information literacy and innovation skills across all subjects.

6) Landslide Simulation Experiment utilized a demonstration set to enhance understanding of the causes of landslides using simple materials such as boxes, plasticines, sand, water, and papers. This experiment helped students understand the concepts in a fun and engaging way.

7) Enjoying Worksheets drew inspiration from the "Improving worksheet" concept by Gail Durbin, which emphasizes the importance of worksheets in museum education, particularly in guided tours and learning within museums. Worksheets are essential as they allow for designated space and time within the museum, as well as providing specific knowledge and narratives for students to absorb. A good worksheet should consider appropriate questioning. In this exhibition, there were two worksheets: "Which event...occurs before a landslide?" and "Where to build a house to be safe from landslides?" These worksheets helped reinforce understanding effectively.

All learning materials were presented to two experts for their comments, suggestions, and recommendations for further improvement to make them more suitable.

4.2.2 The results of learning about landslide hazards from learning materials within the target group

From the results of two worksheets of the target group, namely **Worksheet 1, "Which event occurs before a landslide?"** This task required students to color the events that occur before a landslide. From the experiment using the learning materials and having students complete this worksheet, it was found that 127 students out of 131 students or a percentage of 96.95% could provide correct answers. As for **Worksheet 2, "Where to build a house to be safe from landslides?"** The task required students to draw a picture of a house based on their imagination in a safe position in case of a landslide. From the experiment using the learning materials and having students complete this worksheet, it was found that 131 students out of 131 students or a percentage of 100% could provide correct answers. From the assessment on two worksheets, it was found that the target group had knowledge and understanding about events that could occur before a landslide and awareness about areas that houses could be built to be safe from a landslide.

Based on the assessment in section 2, which consisted of an opinion questionnaire regarding the use of learning materials about landslide hazards, the results could be summarized as follows.

1) The opinion level toward learning skills before experimental application of learning materials had a mean test score of 2.14, indicating a low level of understanding. The opinion level toward learning skills after experimental application of learning materials had a mean test score of 3.67, indicating a high level of understanding.

2) The opinion level toward information skills before experimental application of learning materials had a mean test score of 0, as the students never used the program before, which fell to the criteria of the lowest level of understanding. The opinion level toward information skills after experimental application of learning materials had a mean test score of 4.11, indicating a high level of understanding.

3) The opinion level toward life skills before experimental application of learning materials had a mean test score of 1.99, indicating a low level of understanding. The opinion level toward life skills after experimental application of learning materials had a mean test score of 3.69, indicating a high level of understanding.

4) Based on the assessment conducted before and after the use of learning materials, it was observed that the majority of scores before using the learning materials were at low levels, whereas most scores after using the learning materials reached high levels.

Furthermore, the development of learning materials on geological landslide disaster to raise awareness aligned with the core curriculum of basic education, 2008. Specifically, it aligned with the science learning area for primary school year 6 students, which included indicators related to researching and explaining natural disasters affecting humans and the environment in the local context. These learning materials would facilitate learning that aligned with the basic education curriculum for primary school year 6 students in schools.

4.3.3 Guidelines For Learning About Disasters to Live in the 21st Century

Guidelines for learning to live in the 21st century involve promoting an understanding of the nature, causes, and severity of disasters. It is crucial to create awareness about how to respond when a disaster occurs to prevent and mitigate its impact because it is unknown when a disaster will occur. Being prepared at all times is essential to reduce loss of both life and property. Therefore, learning about disaster preparedness to live in the 21st century involves creating a learning environment that aligns with 21st-century learning skills. This aims to stimulate continuous learning and foster critical thinking skills, raising awareness among

students about potential disasters and promoting preparedness not only for themselves but also for their families and community members.

Learning about geological disasters to raise awareness that aligns with learning skills in the 21st century involves learning skills, information skills, and life skills. It should not solely focus on academic knowledge but should also incorporate fun, encourage participation, and stimulate learning through students' own exploration by having them question and find answers. Teachers play a guiding role by offering advice, facilitating the students' learning process, and designing activities that assist each student in creating their own learning and fostering enthusiasm to create their own knowledge.

To learn in the 21st century, teachers need to adapt the approach by aiming for students to receive learning throughout their lives and their acquired knowledge can be transformed. The transformation results from frequent practice, self-experimentation, experiential learning, gaining firsthand experience, and gaining knowledge from diverse learning sources. These can help students to apply their knowledge in real life. Whether it is observation, when a disaster occurs, they can prepare for it, reduce anxiety, and save their lives in time. This includes the ability to share knowledge with families in disaster preparedness, observe and construct houses that are safe from disaster-prone areas. Additionally, there will be the sharing of knowledge with others and assisting the community as well. Learning in the 21st century involves creating a different kind of learning. In the past, disasters that caused significant losses triggered awareness and learning. Meanwhile, the new kind of learning always provides knowledge and preparation. When a disaster occurs, the public can respond effectively, resulting in increased understanding and reduced loss of both life and property.

5. Conclusion and Analysis

Uthai Thani province has areas prone to landslides total of 964,000 Rai. As for learning about landslides, there have been various studies conducted. In terms of developing learning materials for upper elementary students, appropriate content for the age group would help raise awareness, emphasize the dangers of landslide hazards, urge students to observe if their houses are located on risky areas, urge students to observe their surroundings that could be warning signs before a landslide, and save themselves when the disasters occurred. According to the investigation on international knowledge creation about disasters, the case studies about landslides in the United States showed that they always shared information about landslides to the public, especially for those in areas prone to landslide hazards. The information included scientific news, monitoring, observation, preparation before the disasters, and what to do

during and after the landslide hazards. The case studies of earthquakes and tsunamis in Japan revealed frequent occurrences of earthquakes, but Japan has been increasingly making progress on reducing losses. One crucial method involved using museum spaces as channels to communicate with the public. This could raise awareness about the severity of the disasters and educate people on how to survive if the disasters occur.

The Development of Learning Materials toward Landslide Hazards to Raise Awareness among Upper Elementary Students in Uthai Thani Province to be consistent with 21st century learning comprised of learning skills, information skills, and life skills. The concepts of the development of learning materials included learning, enjoying, and having awareness. The developed learning materials aimed for students to gain knowledge, develop critical thinking skills, enjoy, and raise awareness about disaster prevention for themselves, families, and people around them. This aligns with Wijarn Panich (2015) who suggested about life skills in the 21st century that subject content is important but not sufficient for learning to live in the 21st century world. Presently, learning subject content should be the exploration of the learners. Teachers should guide and design activities that help each learner assess their learning progress.

In this development of learning materials, there was learning material that could be borrowed by students to take home. It was **the pop-up book "Knowing What to Do When Faced with Landslides."** From questioning the teachers afterward, it was found that many students showed interest in borrowing this book. This would be beneficial for reviewing knowledge. The use of this learning material at home could be fully facilitated by using smartphones to learn from this book and spread knowledge to family members.

From the study, it was found that knowledge cultivation should start during childhood. Learning during childhood helps to create familiarity. Therefore, museums or various learning sources should consider developing media or learning activities aimed at promoting knowledge for children. This involves incorporating fun and new methods to prevent children from feeling bored, stimulating a desire to learn. This would help to achieve effective learning outcomes. The educational role of museums is to support the development of students' core skills, including creativity, critical thinking, data synthesis, potential for innovation, and collaboration abilities (AAM, 2015, as cited in Pattaraphon Phuthong, 2015).

This research revealed that the development of learning materials for children needs to select appropriate content and media to promote accurate understanding during their age range. The developed learning materials could be applied to areas prone to landslide hazards or various areas where the knowledge providers desire to provide knowledge to the public.

Furthermore, they could serve as learning materials in classrooms or non-formal educational learning sources. Additionally, these materials could serve as prototypes for learning materials adaptable to other types of disasters, which could help contribute to raising awareness and preparing the public to cope with potential disaster situations effectively.

6. Recommendation, and Limitation

Recommendations for the development of learning materials to improve for more suitability are as follows: 1) In this research, a male main character was utilized consistently in all learning materials, which aligned with the age group of the target audience. The character had a smiling face, relatable appearance, and wore an explorer's costume. However, it is suggested to introduce a female main character alongside the male character to foster a sense of inclusion and equality among female students regarding their careers. 2) When incorporating technology into material development, budget considerations for maintenance are crucial. The use of Augmented Reality (AR) technology in this research involved costs such as renting space for storage and uploading content to the website for display, with expenses based on the rental duration. To ensure continuous display of content, adequate budget reserves are essential. Additionally, the reliance on technology requiring smartphones or electronic devices might be challenging for the target group, particularly students from a specific province who might lack access to such devices. It might result in limiting their full engagement with the content.

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