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A Theoretical Framework to Study Conceptual Understanding and Earthquake Readiness Among School Students at Ranau, Sabah

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ABSTRACT

School students are a group that is very vulnerable to the risk of earthquake disasters in schools. Hence, a clearer understanding of the concept of earthquakes and readiness for earthquakes is a key element that needs to be given special attention by teachers in educating students. This scenario has prompted various studies to be conducted to evaluate and identify methods and strategies to improve understanding of concepts and earthquake preparedness to students. This is to help reduce risk and build disaster resilience among students. Therefore, the integration of the use of robots in the game learning module is able to help students in understanding the important concepts of earthquakes and the readiness that need to be taken when facing this disaster. This is due to the potential of the inclusion of robots in the teaching and learning process of games to boost student intrinsic motivation, enhance their critical thinking, problem-solving, and metacognition skills, and make it simpler for them to understand difficult concepts. To ensure that the teaching and learning process of the robot game module is perfectly implemented and meets the learning objectives, it is crucial to choose the appropriate theory. This article suggests a theoretical framework based on inclusive review of literatures to explore conceptual understanding of earthquake and earthquake preparedness among school students at Ranau, Sabah.

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Contribution/Originality: This article highlights earthquake education issues that are still relatively new in Malaysia. In addition, the study contributes to the existing literature on the application of theories in an effort to provide scholars and academics with approaches to teach and develop students who would be able to withstand future earthquake disasters.

1. Introduction

Children are a very risky group compared to adults with the threat of earthquakes (Ersoy & Koçak, 2016; Rahman, 2019; Sapkota & Neupane, 2021). Several overseas studies conducted also show that students who live in high-risk areas receiving the threat of earthquakes experience emotional disturbances and physical injuries immediately after the earthquake occurs (Mutch, 2015; Ersoy & Koçak, 2016; Sözen, 2019; Beaglehole et al., 2020). This situation raises the question of whether the students have the knowledge and proper preparation in case a large earthquake occurs again in the future.

Malaysia is at risk of earthquake phenomenon which is influenced by regional and local earthquakes. Tongkul (2020) states that Peninsular Malaysia has been hit by large earthquakes from West Sumatra several times while earthquakes from the Sulu and Celebes seas cause small tremors in Sabah periodically. Although the effect is small, it remains a cause of concern for the local community especially in the Ranau district which is the epicenter of the earthquake (Harith et al., 2021; Takano & Saito, 2017; Tongkul, 2021). The proof is that the earthquake disaster that occurred in Ranau, Sabah in 2015 and 2018 has caused special attention to be given to this earthquake disaster. Moreover, the issue raises the question of whether the school community, particularly the students in the Ranau district, has a thorough understanding of earthquake concepts and readiness in the event that a large earthquake occurs in the future. All these problems need to be given serious attention by all parties, especially school teachers in Ranau district.

The scholars stated that earthquake education should be widespread and emphasized by all parties in order to create a society that is literate in the knowledge of earthquake disasters. This is because it is important to implement to reduce the risk of loss of life and property (Kang et al., 2017; Zhu & Zhang, 2017; Zhang et al, 2018). In this context, the best method to produce knowledgeable citizens to face earthquake disasters is through formal education (Shiwaku & Shaw, 2016; Ersoy & Kocak, 2016; Yao, 2019; Henson, 2020). Before imparting earthquake knowledge, the level of understanding and readiness among school students must be considered first (Bikar et al., 2021a). In this context, teachers are a source of support that is highly trusted by students especially during earthquakes (Bikar et al., 2021b; Mooney, 2021). With the support and knowledge imparted by the teacher able to reduce the risk of earthquake threats among students.

In this context, students must fully comprehend the idea of earthquakes, including its definition, cause, kind, process, magnitude, and effects (Bikar et al., 2021b). This is to ensure that students are able to make interpretations related to earthquakes in order to reduce the risk of death when an earthquake disaster occurs. In addition, the readiness - that is, the actions that need to be taken covering three main dimensions, which are

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preparation before, during and after facing an earthquake must be mastered by students to prevent them from taking actions that endanger themselves in the event of an earthquake.

To overcome this problem, scholars state that technology in education can be a tool to produce an effective learning process and can produce students who are competent in mastering knowledge. This has caused various studies to be carried out to identify strategies and methods to provide knowledge of earthquake disasters to students in a more interactive way that is in line with 21st century learning technology (Muzani Cahyani et al., 2020; Mohadjer et al., 2021). The concept of integrating game methods by teachers in the teaching and learning process of earthquake in the classroom is able to support the teaching and learning process more effectively that is adapted to teaching aids or teaching aids (Zulfhikar, 2020; Feng et al., 2021; Ma et al., 2021; Mohadjer et al., 2021; Sözcü, 2021). However, in recent times, robot technology has become increasingly popular to help implement a better and systematic learning culture.

Scholars state that robots are a 21st century teaching system that can be used in the teaching and learning process (Parra-González et al., 2021; Amin & Ahn, 2021; Gorakhnatha & Padmanabhan, 2017). One of the most important methods for students to acquire important knowledge and skills is through game. Accordingly, robots are an alternative technology that can be used as teaching aids that facilitate the transfer of the content of a topic more effectively (Murphy, 2000; Sánchez et al., 2019). Based on this view, the integration of the use of robots in the game learning module is able to help students in understanding the important concepts of earthquakes and the preparations that need to be taken when facing this disaster.

This is because the interaction of robot in the process of teaching and learning games can increase students' intrinsic motivation (Bikar et al., 2020) and improve critical thinking skills (Gorakhnatha & Padmanabhan, 2017), problem solving and student metacognition, as well as their ability to learn complex things easier (Parra-González et al., 2021; Bikar et al., 2022). However, in order to ensure that the use of robot game elements in the learning process is successfully carried out perfectly, benefits students and achieves the learning objectives, teachers need to do preliminary planning so that the game or application selected matches the content of the lesson to be delivered, including the teacher's own skills to control which game application to use.

Therefore, the researcher uses four types of theory, namely Concept Change Theory, Vygotsky's Social Constructivism Theory, Bloom's Taxonomy Theory and Planned Behavior Theory as a basic guide in the formation of this theoretical framework. The robot-based game module is based on all the theories that are used as the main reference source. This is to get an initial understanding to explain the relationship between all theories to achieve the objective of the study, which is to address the issue related to understanding the concept of earthquakes and preparing for earthquake disasters among school students.

2. Literature Review

2.1. Conceptual Change Theory

Learning earthquake science requires an understanding of the main concepts of the correct earthquake to avoid misunderstandings or misconceptions occurring in

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students. When this problem is not dealt with well, it can interfere with the effectiveness of students' learning to receive new knowledge and ideas, thereby preventing meaningful learning. In this context, conceptual change theory is a theory that is often used in providing a framework for students' understanding to build new knowledge or to improve learning, especially in the field of science (Posner et al., 1982; Hewson & Hewson, 1992). However, Agiande et al. (2015) concluded that the concept change theory is an effective teaching concept and teachers should use it in other learning areas besides science and environmental education. Therefore, conceptual change theory is used in this study to help the researcher examine how students are able to learn and understand more deeply about the main concept of earthquakes more effectively.

Based on this theory, learning is an inquiry process that refers to the change of existing concepts involving the beliefs, ideas, or ways of thinking of a student (Posner et al., 1982). In the context of learning the topic of earthquakes, learning is a process of inquiry by bringing conceptual change (replacement or strengthening) of the basic concept of earthquakes which includes definitions (meaning, scale, location), causes of earthquakes, processes and effects of earthquakes. There are four teaching conditions that can help students change their concepts and accommodate changes (Posner et al., 1982: 214). Students must become dissatisfied with their existing understanding and they must be able to understand new information (intelligible) and consider new concepts as reasonable (plausible). Finally, students must accept that new information can be used to solve problems and to build new (fruitful) knowledge.

For example, students must be dissatisfied with their existing concepts related to the concept of earthquakes such as definitions (meaning, scale, location), causes of earthquakes, processes and effects of earthquakes before changing and accepting more concrete and reasonable scientific concepts. The second condition that needs to be met is that students must be able to understand information or new concepts of earthquakes (intelligible). In this context, students form their own knowledge based on the results of their interaction with the environment and their respective experiences (Posner et al., 1982). This is so that students have preliminary knowledge and changes after receiving new concepts in learning.

This in turn causes students to be satisfied and understand clearly related to the new concept of earthquakes based on scientific evidence (plausible). Any new concept adopted must appear to have the capacity to solve the problems generated by its predecessors. Otherwise, it will not seem like a reasonable choice. Finally, students can feel the benefits of new concepts and ideas (fruitful) to solve problems in their lives (Posner et al., 1982). Based on the explanation above, indeed the theory of conceptual change has a positive impact especially on students and teachers in all subjects. Therefore, this theory is suitable to be used as a guide and main reference for researchers to plan and structure teaching in order to adhere to the essence of this theory to help students learn and understand more deeply about the main concepts of earthquakes more effectively.

2.2. Planned Behaviour Theory

The theory of planned behaviour is also the guiding principle in this study in examining the level of readiness before, during and after school students face an earthquake disaster. This theory is an expansion of the theory of reasoned action pioneered by Icek Ajzen (Ajzen, 1991). This theory has been widely used in various research fields such as

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health, education and health science (Pooreh & Nodeh, 2015; Wikamorys & Rochmah, 2017; Si et al., 2019). Vinnell et al. (2021) also stated that this theory is the main predictor of a behaviour is the intention to perform it. Attitudes toward the behaviour, views about societal norms related to the behaviour, and control beliefs over the behaviour all influence intentions.

Three main factors namely attitude, subjective norm and perceived behavioural control influence the individual's involvement in a certain behaviour. According to Ajzen (1991), attitude factors are personal beliefs about behaviour and evaluation of the results. In the context of preparing for this earthquake, each student has his own belief in the teaching and learning process in the classroom that will increase the willingness and motivation of students to support the change. Expected benefits from change, which is an individual's positive assessment of behaviour regarding change, is used to measure attitude. This means that individuals who have a high expectation of benefit from change will support any change made in the learning process in the classroom.

Subjective norms mean the perception of social pressure to either do or not do a behaviour (Ajzen, 1991; 2020). Ajzen (2020) further explained that subjective norm is a social factor term that refers to a person's perception of social pressure received from people who are considered important in their lives, whether to do or not to do a certain behaviour. For example, subjective norms refer to a student's perception of the people around them, including those close to them, whether they support or discourage them from performing a behaviour. Interpersonal influences (peer support, teacher support and family support). Therefore, a student who has high interpersonal support will support any changes he makes especially in meaningful learning.

Behavioural control is a control belief about the ability and opportunity to perform one's behaviour. According to Ajzen (2020), the perception of behavioural control is the perception that it is difficult or easy for a person to perform a behaviour that is influenced by the experiences and obstacles that a person has gone through. This refers to the extent to which students believe that there are various factors that either facilitate or hinder their ability to act. Therefore, a student who has behavioural control will show high support for changes in the context of the teaching and learning process of the earthquake concept implemented.

Overall, the three factors will determine the individual's willingness to perform their respective behaviour (behavioural intention), and the greater the likelihood that the individual will perform a certain behaviour perfectly (Egbelakin et al., 2015). Therefore, this study uses the theory of planned behaviour as a basic theory to explain the readiness of school students to face earthquake disasters.

3. Robotic Game Module

3.1. Vygotsky's Social Constructivism Theory

Scholars state that this theory has become the main basis for many educational researches, namely cognitive development that emphasizes the social context to support the learning process (Daniels, 2001; Pritchard, 2009; Jawad et al., 2021). This theory helps to understand the development of learning that should happen in a student. Scholars also state that the learning process based on this theory is active with various social mediating activities (Schunk, 2012).

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Theory of social constructivism focuses on the learning process in which students form and acquire their own knowledge through interacting with others so that students are able to create and build their own knowledge and reality (Pritchard, 2009). In the context of learning earthquake science, students can interact, cooperate and compete with others through technological games such as robots. Students will share and mutually build new knowledge sparked by diverse ideals. In addition, engagement with other people or second parties will provide opportunities for students to evaluate and improve knowledge (Driscoll, 2014). The concept of the Zone of Proximal Development (ZPD) was introduced to see the real relationship between the development process and learning ability.

Accordingly, this theory underlies the learning of earthquake topics based on the robot game module. Game activities are said to be aspects that help children build the student's Zone of Proximal Development (Jawad et al., 2021). In this context, if the student can do the robot game activity task by himself, then the content of the lesson is said to be in the lower zone (things that the student can do by himself). On the other hand, if students can master the robot game activity task with the guidance of others, then the task is at the ZPD level. But if the content of the lesson is outside the upper-level zone (things that students cannot do), the student will not be able to master the content of the lesson even with the guidance of others.

With that, the scaffolding technique was introduced to help the content of the lessons in the ZPD, which is to follow the process of guidance and assistance. The use of psychological tools which are game robots as scaffolding aims to guide students to think in a systematic and directed manner (Hyerle & Alper, 2011) who are guided by teachers towards the development of systematic thinking patterns in mastering abstract concepts (Bahar et al., 1999). Therefore, the use of a cooperative learning through playing approach in the teaching and learning process as a cognitive strategy that can be utilized by students in mastering the standard content of earthquake topics. Children engage in cooperative activities because they foster cognitive growth (Slavin, 1996) and have a good effect in increasing the level of student achievement (Jawad et al., 2021).

3.2. Bloom's Taxonomy Theory

Bloom's taxonomy is a student's thinking or cognitive level that is referred to in order to produce an appropriate and effective assessment. The level of students' thinking skills needs to be tested to get a result to ensure that the learning plan that is compiled can be evaluated and carried out better (Huitt, 2011; Zorluoglu & Güven, 2020). However, Anderson and Krathwohl have revised Bloom's taxonomy to fit modern educational objectives that are more focused on outcomes, including changing the names of the levels from nouns to active verbs, and reversing the order of the top two levels (Huitt, 2011). Bloom's taxonomy theory is used for the purpose of planning and organizing module activities based on the cognitive level of students so that the quality of learning outcomes is more optimal. In addition, it helps teachers to be able to make assessments related to teaching objectives (Zorluoglu & Güven, 2020).

In this context, the remembering stage is the lowest stage where students need to recognize, list, describe, identify, retrieve, name, find or locate. For example, students know the Richter scale of earthquake, the symbol of the Pacific Ring of Fire, the location of earthquakes on the map. The next stage is understanding. Students will be able to

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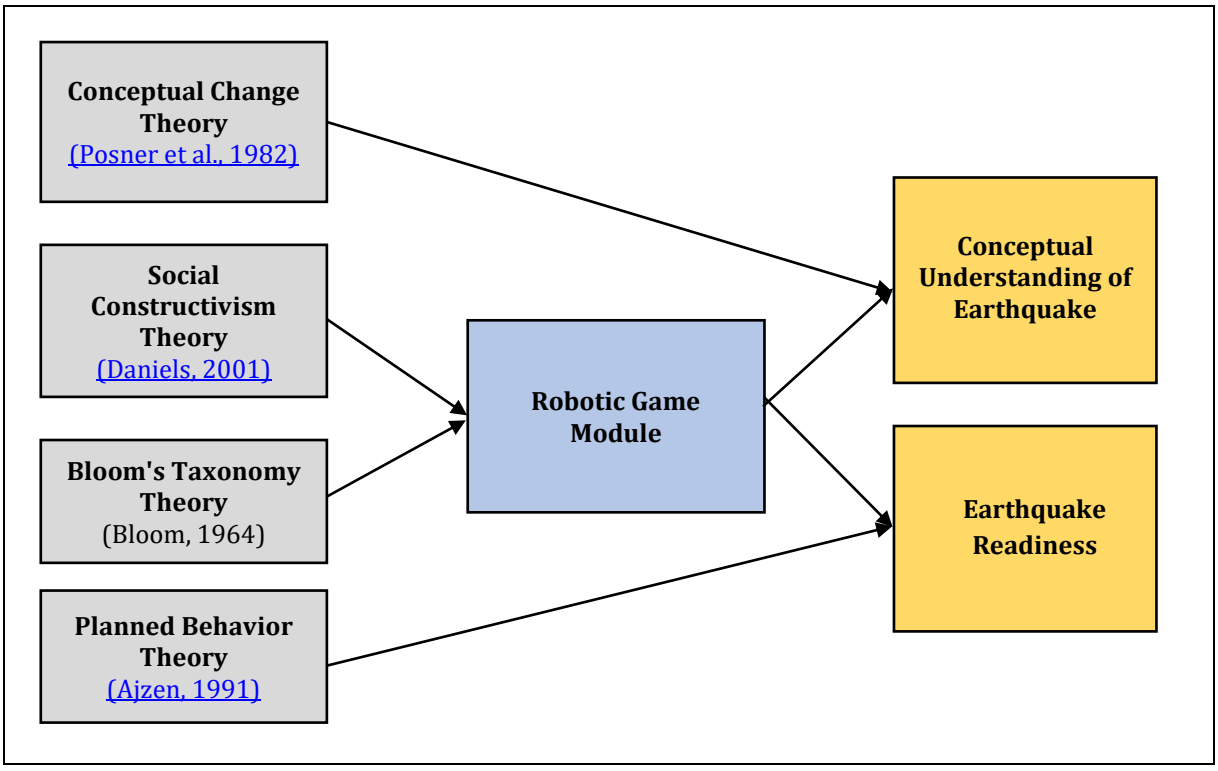
make a description or meaning for the definition and cause and occurrence of earthquakes as well as preparations that need to be taken based on the activities of the robot game module. Meanwhile, the application level is the next level but still in the low category. The application stage will make the student an implementer by running, using or implementing. For example, students will solve problems using concepts and factual knowledge such as games on the earthquake process subtopic.

The following level is the high level. The higher level includes the levels of analysis, evaluation and creation. The analysis level requires students to explain the relationship that occurs about the phenomenon of earthquakes. For example, students have plotted the location of the earthquake and carried out preparatory activities that need to be done before, during and after the earthquake, based on the robot game activity, students connect the links to support problem solving based on reasonable evidence. In addition, the assessment level requires the game activity of this module to enable students to make decisions based on criteria and standards (Huitt, 2011). Students are able to combine a structure more clearly and convey thoughtful ideas to others. Finally, the creating level which is the sequence of game activities can help students form a coherent overall idea or generate new ideas regarding all the subtopics of the robot game module.

4. A Theoretical Framework to Study Conceptual Understanding and Earthquake Readiness

This study was conducted to examine the understanding of the concept of earthquakes and preparation for earthquakes among high school students. Four types of theories namely Concept Change Theory, Vygotsky's Social Constructivism Theory, Bloom's Taxonomy Theory and Planned Behaviour Theory help the researcher understand the focus and problem of the study. Thus, a visual representation of how the theories used are linked and shown in the theoretical framework of the study as shown in Figure 1.

Figure 1: The Theoretical Framework of the Study



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The researcher has built a theoretical framework based on the discussion of the theories underlying this study. It is also to introduce, explain and show the relationship between all these theories. The conceptual change theory is utilised as a guide in this study to comprehend the main concepts of earthquake among students. In addition, the Planned Behaviour Theory serves as the primary resource for earthquake preparation studies among students. Simultaneously, the Social Constructivism Theory is applied to the design and development of systematic robotic game module teaching and learning units based on particular subject matter. Bloom's Taxonomy Theory is also applied in the design of assessment forms and activities that enable students to understand essential earthquake concepts and become better prepared for earthquakes. Gentner (1983) states that a theoretical framework is a model that explains the logical sequence of relationships between factors that are identified as important in relation to a research problem. This theoretical framework is able to connect a research to existing knowledge and provide an explicit statement of theoretical assumptions to the reader (Singh et al., 2016). In addition, it helps the researcher lay a foundation that will support the analysis and help the researcher interpret the results and make broader generalizations.

5. Conclusion

The purpose of this article is to provide a comprehensive theoretical framework to study the understanding of the concept of earthquakes and preparedness for earthquakes among high school students in Ranau, Sabah. The article also discusses the application of game methods adapted to various types of tools and multimedia technology capable of being used as teaching aids that can support the teaching and learning process of teachers to teach students in a subject especially the science of preparing for earthquakes. In this study, a robot-based game module can enable students to master the content or abstract concepts about skills and correct actions taken by students before, during and after facing an earthquake. In addition, the robot as a tool for students to design their learning goals in addition to developing the potential of collaborative learning. Therefore, a theoretical framework based on the literature related to this study has been proposed.

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Conflict of Interests

The authors reported no conflicts of interest for this work and declare that there is no potential conflict of interest with respect to the research, authorship, or publication of this article.

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