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The Feasibilty of Student Worksheets with STEM Approach to Understanding of Earthquake Disaster Mitigation

Kosim[1*], Riri Deansikutari[2], Muh. Makhrus[3], Gunawan[3], Hikmawati[4]

[1] Faculty of Teacher Training and Physics Education University of Mataram, Indonesia.

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Corresponding Author:
Kosim
kosim_fisika@unram.ac.id

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Abstract: This study aims to feasibility of student worksheets with a STEM approach in earthquake disaster mitigation The STEM approach is an approach that combines four aspects of science, namely science, technology, engineering and mathematics. The research method used is Research and Development (R&D) with the ADDIE model consisting of four stages, namely Analysis, Design, Development, Implementation, and Evaluations. The research phase is limited to the stage of development. The product developed is the Student Worksheet. The feasibility of the student worksheets developed was seen from the results of the validation. by three experts who calculated the validity and reliability of the student worksheets. The response questionnaire was distributed to 30 students of the Physics Departement in FKIP - University of Mataram. The results show that the validity of student worksheets was included in the very valid category and it was reliable criteria. The results of student responses showed a very good response (98.33%). Beside that the implementing of student worksheets to 30 students show good assessment (93.33%). Thus, it can be concluded that the student worksheets that have been developed with the STEM approach can improve the understanding students to the earthquake disaster mitigation.

Keywords: Student Worksheet; Earthquake Disaster Mitigation; STEM approach

Introduction

Indonesia is a country that is located on three tectonic plate meeting paths that are actively moving so that in Indonesia earthquakes often occur (Hidayati, 2008). The three plates are the Eurasian plate, the Indo-Australian plate, and the Pacific plate which makes this area vulnerable to tectonic earthquakes (Anies, 2017). This position causes the islands in Indonesia to often experience earthquake vibrations, especially at plate confluence, namely the meeting of the Indo-Australian plate along the islands of Sumatra, Java, Nusa Tenggara Islands, and the meeting of the Indo-Australian and Pacific plates on the island of Java. From time to time the Indo-Australian plate will subduct the Indonesian earth and vibrate the rock layers in the form of an "earthquake". Indonesia is also on the "ring of fire" path. where Indonesia has the most active volcanoes in the world. The "ring of fire" or often known as the Pacific Ring of Fire is an area that often experiences earthquakes due to volcanic eruptions.

Indonesia is recorded to have 130 volcanoes, 17 of which are still active. This condition makes the Indonesian region also vulnerable to volcanic earthquakes (Zudhi, 2019). One of the areas in Indonesia that has an active volcano is the island of Lombok, namely Mount Rinjani (Kholil et al, 2019). Mount Rinjani is the second highest mountain in Indonesia with an altitude of 3726 m above sea level. According to the Bandung Center for Volcanology and Disaster Mitigation, Mount Rinjani is still on alert.

Earthquakes are natural disasters that cannot be predicted when they occur. Earthquakes do not give signs like other natural disasters. Therefore, efforts are needed that can reduce the risk of earthquakes, namely Earthquake Natural Disaster Mitigation (Ayub et al., 2021).

Disaster risk reduction requires the right strategy so that losses from all aspects can be reduced. One of the

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strategies in reducing disaster risk is mitigation which is implemented in the world of education. According to Law no. 24 of 2007 Article 1 Paragraph 9, mitigation is a series of efforts to reduce disaster risk, both through physical development as well as awareness and capacity building to face disaster threats.

The role of universities is very important to support the government in disaster management in Indonesia. Although the Government has established the National Disaster Management Agency (BNPB) and the Regional Disaster Management Agency (BPBD), considering the vast territory of Indonesia and the diversity of available resources, the government needs support from all elements of society, including universities.

Disaster education needs to be developed by universities, especially those located in disaster-prone locations. Mataram University is one of the universities located in a disaster-prone location, namely West Nusa Tenggara. Considering that NTB is an area that is prone to natural disasters, so on the map for natural disaster management, the NTB area is a priority. With the disaster mitigation lessons learned by students in learning, it is hoped that students can convey the knowledge, they have gained to the community (Kosim, 2021).

Based on the results of the questionnaire analysis of initial knowledge responses to 20 students of Physics Education FKIP University of Mataram, it was found that students needed earthquake disaster mitigation lessons because 70% of the 20 students had never attended training or workshops on disaster mitigation, especially earthquake disasters. Therefore, this is a consideration for researchers to develop –of teh worksheet with the STEM approach in earthquake disaster mitigation learning.

Student worksheets can be an alternative to supporting learning that can be used to support optimizing learning. Student Worksheets serves as a guide for students in learning and discovering concepts through the activities carried out. This is in line with the statement of Guruh, Anjarwati, & Prayitno (2018) that the use of Student Worksheets can make student learning activities more focused. Student Worksheet that is designed in an attractive and systematic way can help students learn more actively, both independently and in groups.

The implementation of the learning process requires the right model and approach according to the subject in order to achieve the learning objectives. Problem based learning is a learning model that develops students' abilities to develop various perspectives on active, meaningful learning and can train students' communication in learning (Celik, et al. 2011). In addition, according to Sudewi et al. (2014) the PBL model can give students more opportunities to actively seek and manage information independently, and build their own knowledge based on the experience they have gained. Zulkarnaen et al. (2022) say PBL is a learning that requires students to construct their own knowledge through the problems given.

The STEM approach is a learning approach that combines two or more fields of science, namely science, technology, engineering and mathematics (Ismayani, 2014). In line with the opinion of Torlakson (2014), the approach of the four aspects is a harmonious pair between what happens in the real world and problem-based learning (problem base learning).

Based on the description above, the researcher developed a student worksheet based on problem base learning with a STEM approach in earthquake mitigation learning.

Method

The type of research used in this research is research and development. The research model used is the ADDIE models developed by Dick and Carey (1996) and adapted from (Mulyatiningsih, 2011) which consists of 5 stages, namely analysis, design, development, implementation, and evaluation. The stage of research is shown as figure 1.

In the analysis phase, there are several stages of analysis carried out, namely needs analysis, student analysis, concept analysis and analysis of the specification of learning objectives. The results of these analyzes are used as the basis for developing student worksheets based on *problem base learning* with the STEM approach in earthquake mitigation learning.

The design stage is the stage of making or designing the product to be developed. The product in question is a student worksheet based on problem base learning with a STEM approach in earthquake disaster mitigation learning.

Development stage (*develop*) is the stage of making a product from a design that has been completed and then tested for validity by the validator. The validators in this study consisted of three people, namely physics education lecturers.

The instrument used in this study was the Student Worksheet validation which was used to obtain assessments as well as comments and suggestions from the validator, and the response questionnaire was used to obtain responses and suggestions from students on the developed Student Worksheets.

The data analysis technique used to measure the validity of the student worksheets that have been developed is the scale *likert* and reliability using statistical analysis "percentage of agreement". Then the response to the questionnaire is calculated by looking for the percentage of responses. Validity is then categorized into several levels which are shown in Table 1.

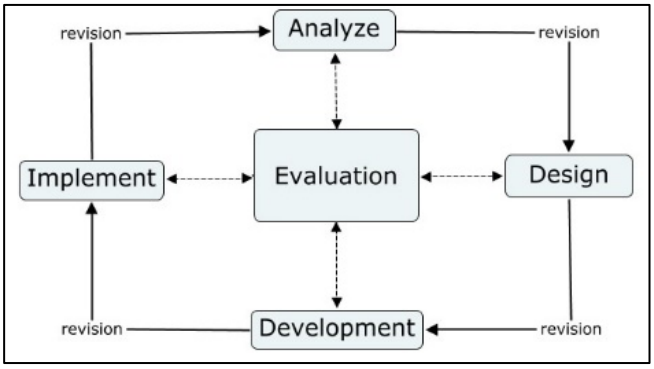

Figure 1. Diagram of stage research

Table 1. Validity Assessment Criteria

Average	Criteria
1.00 – 1.75	Invalid
1.76 – 2.50	Quite Valid
2.51– 3.25	Valid
3.26 – 4.00	Very Valid

(Ratumanan and Laurens, 2011)

The average validation value of the validator is calculated by the modified equation, namely:

$$NA = \frac{\sum_i^n v_n}{n} \quad (1)$$

Information:
NA*:* mean validity
v_n: value of the validity of the nth expert
n: many experts

The reliability of the developed student worksheets is calculated using statistical analysis of "percentage of agreement" namely:

$$PA = \left(1 - \frac{A-B}{A+B}\right)100\% \quad (2)$$

Where A is the highest score of the validator and B is the lowest score of the validator. Student worksheets are said to be reliable if the reliability value is greater than 75% (Makhrus, et.al 2020). The percentage of student response questionnaires is calculated using the equation response percentage R:

$$R = \frac{number\ of\ positve\ responses}{number\ of\ respondent}\ x100\% \quad (3)$$

The results of student responses are then categorized into several levels as shown in table 2.

Table 2. Category of Response Percentage Calculation Results

Score (%)	Criteria
81 - 100	Very good
61 - 80	Well
41 - 60	Pretty good
21 - 40	Not good
20%	Very Not Good

(Arikunto, 2010)

Result and Discussion

The results of student analysis that have been carried out show that students' knowledge of disaster mitigation, especially earthquake disasters, is very lacking so that disaster mitigation learning is needed that is implemented in the world of education. Based on this, a student worksheet based on problem base learning was developed with a STEM approach in earthquake disaster mitigation learning. Concept analysis and specification of learning objectives are carried out by selecting core competencies and basic competencies that are used as references to develop student worksheets.

The design is carried out to produce an initial draft of the product before it is developed. The initial draft of the product developed is arranged according to the material and learning approach used. The next stage is the development stage which aims to get a product assessment from the validator. The data from the assessment results from the validator was then analyzed to determine whether the developed student worksheets were valid or not.

The last stage is the limited implementing the product to students of Physics Education in Teacher training and Education University of Mataram. The number of students who take this lecture with student worksheets based on problem base learning with STEM approach in earthquake disaster mitigation learning, there are 30 students. Based on table 3 student worksheets based on problem base learning with the STEM approach in earthquake disaster mitigation learning that was developed, the validity value by the validator had an average score of 3.61 with a very valid category. The results of the reliability analysis of student worksheets by physics lecturers can be seen in Table 4.

Table 3. Student Worksheets Validation Results by Physics Lecturers

Product	Lecturer			Score Average	Category
	V1	V2	V3		
Student Worksheets	3.73	3.37	3.73	3.61	Very Valid

Table 4. Reliability Analysis of Student Worksheets by Physics Lecturers

Product	Lecturer			Average *Percentage Agreement (PA)*	Category
	V12	V13	V23		
Student Worksheets	89.12%	93.17%	89.12%	90.47%	Reliable

Based on table 5 student worksheets based on problem base learning with the STEM approach in earthquake disaster mitigation learning that was developed, the response percentage was 98.33% with a very good category. The result of evaluation quality respondent limited implementing is shown in Figure 1.

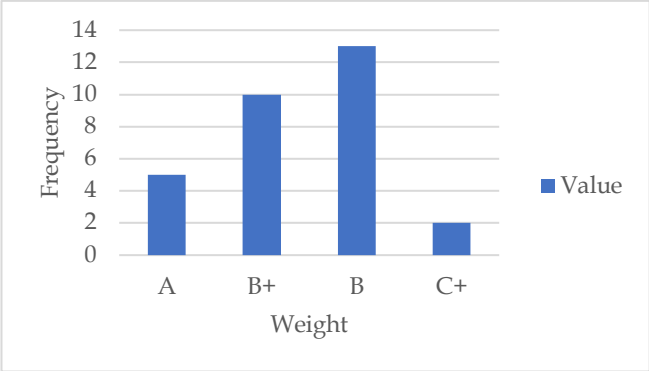

Figure 2. Evaluation quality respondents

With assessment criteria for figure 1 is shown in table 5. Based on the result which is shown in figure 1, that the average value to understanding to earthquake disaster mitigation through student's worksheet is 75.83. The students who get value B above (28/30) * 100 % = 93.33 % get good assessment. Therefore, the learning with Student Worksheets will increase student learning motivation and also it can have a positive effect on their thinking abilities.

Tabel 5. Assessment Criteria

Value	Weight
>85	A
80-85	B+
75-80	B
70-75	C+
65-70	C
55-65	D+
45-55	D
<45	E

The STEM approach to learning has received positive responses from both teachers and students. Student learning motivation increases when the teacher applies the STEM approach. Therefore, this approach is one of the recommended approaches for teachers in Indonesia, especially in science learning (Permanasari et al., 2021).

The STEM approach can be applied face-to-face, online, or blended learning. After the COVID-19 pandemic or the new era, learning has not completely stopped from online mode, in fact the majority of teachers have implemented blended learning in their classes. This is in accordance with the development of the dynamics of education throughout the world, namely the use of all-digital technology (Ardianti et al., 2020).

The STEM approach is very good at developing 21st century student competencies, namely critical thinking skills and skills in communicating with other people (Oktavia & Ridlo, 2020), as well as students' ability to solve a real problem (Astuti et al., 2021), including how to students' ability to understand various phenomena that occur in the environment around them, namely knowledge about earthquake disaster management that often occurs in Indonesia.

The STEM approach can also be modified into STEAM namely STEM and Arts. The modification of Arts into STEM attracts students' interest in producing a work, product, artifact that will provide a meaningful learning experience for them. Arts is an innovative element in STEM because each student or group of students can explore in designing project assignments. Students can create independently according to imagination to create a product that has artistic value (Aguilera & Ortiz-Revilla, 2021). The Arts element in STEM will be very suitable to be applied from an early age, starting from the elementary school level (Seage & Türegün, 2020), at the junior high school level (Retnowati et al., 2020), high school (Changtong et al., 2020), to university (Altakahyneh & Abumusa, 2020).

The STEM approach not only increases learning outcomes in the realm of knowledge and skills, but also improves learning outcomes in the attitude aspect (Altakahyneh & Abumusa, 2020). Student activity during the learning process also increases through the application of the STEM approach (Tunc & Bagceci, 2021). The STEM approach has also been shown to improve geographic skills and spatial thinking abilities (Putra et al., 2021). Therefore, the STEM approach to learning has become a new trend, not only in Indonesia but also in Asia, even throughout the world (Wahono et al., 2020)

Conclusion

Student worksheets with a STEM approach to understanding of earthquake disaster mitigation dveloped has valididty of very valid and also reliable. Bisesed that the response of students 98.33 % (very good) and the result of implementation Student worksheet get 93.33 % good assessment So that the developed the student worksheet is appropriate to be used to improve

understanding students to the earthquarke disaster mitigation.

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