Science environment technology and society approach learning to improve natural disaster mitigation literacy

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Abstract. This research is motivated by the location of Indonesia in disaster areas. But the readiness of citizens to deal with disasters is still low. This study aims to (1) develop natural disaster learning packages with the vision of the Science Environment Technique Society (SETS) which is integrated in science subjects, (2) implement disaster prepared teaching materials, (3) improve teacher understanding and skills, students about concepts, principle, the practice of saving oneself in the event of a natural disaster. This research was conducted in collaboration with teachers in primary and secondary education. Theoretical exploration and expert evaluation are carried out on the features of themes and sub-themes of disaster learning models that are integrated in SETS vision science subjects. Data analysis technique used (1) descriptive percentage, (2) normalized gain test, and (3) t-test. The results of this study in the form of five features of learning models such as (1) syllabus, (2) lesson plans, (3) learning methods, (4) teaching materials, and (5) assessment instruments. Desimination of the five features was declared feasible to increase students' understanding of disasters. This is seen from the test results obtained by students experiencing an increase (gain) from pretest to posttest starting from 53.5% to 80.3%.

1. Introduction
Disasters, whether natural or man-made, have a significant impact on all individuals in the world. Asian countries continue to face the risk of vulnerability concerning the conditions of the human system and the rapidly changing environment, and the events of natural disasters that bring huge losses to human life. Natural disasters have caused difficulties with physical impacts that broadly involve human casualties and loss or damage to property and infrastructure [1][2][3]. Accepting the truth that disasters cannot be prevented at this time, various works are carried out to minimize damage caused by natural disasters or disasters caused by humans themselves [4][5]. The impact of disasters can be reduced by effective disaster management through the development of community awareness education and training programs on disaster risk knowledge [2][6][7]. Reducing the impact of disasters, minimizing the spiritual and material losses experienced are mainly made possible by the education of every individual in the community. It is a well-known fact that quality education will bring success in the fight against disaster [5]. Education can play a key role in promoting preparedness behavior. Education refers to the class-based education which is usually delivered systematically by trained teachers or educators in structured environments such as schools, colleges, or universities [8].

SETS is an approach that integrates elements of science, environment, technology and society in learning subject matter. Learning science with the SETS approach can make students more interested in learning science, because they will see the usefulness of knowledge being studied more broadly in real-life contexts. After understanding the benefits of the knowledge learned, students will be more interested in and enjoy the lesson and furthermore, the learning will bring students to be more familiar with science, environment, technology and society as a unified whole with various implications when associated with moderate knowledge they learned. Indirectly education with SETS directs students to have care and empathy for the environment and the community system. SETS vision learning is intended to help students understand science and its development, and the influence of the
development of science of technology, environment and society reciprocally. This learning must be able to make students who learn it understand the relationship of each element in SETS. The inseparable relationship between science, environment, technology and society is a reciprocal relationship that can be assessed the benefits and losses incurred [9]. The concept of natural disasters will be easily understood if explained using the SETS vision learning model, namely the integration between science, environment (environment), technology (technology), and society (Society) [10].

2. Method
This research is a research and development (R & D) carried out in collaboration with teachers in primary and secondary education. Figure 1 below is the steps taken in development research.

![Figure 1. Development Research Scheme](image)

Tests are conducted to determine the readability of teaching materials, learning plan (in RPP), and characteristics of evaluation instruments and questions. In addition, to determine the amount of time needed to complete each of the planned learning themes and tests. Thus, the model teacher and test maker can estimate the appropriate amount of time and a number of questions. Product development trials are carried out through two stages, namely individual testing and field testing. Individual test: first carried out by experts and teachers in the field of study. The second is imposed on several teachers and students (5-10 people). Field tests are carried out in model schools (80-100 students).

Based on geographical and historical considerations of the occurrence of disasters, the city of Semarang was designated as an empirical test site for learning models for floods and landslides with SETS vision. The subjects of individual trials are education experts and practitioners (3 teachers), while the subject of limited field trials is several teachers and students of Elementary School/MI and Junior High School/MTs. Field trial subjects were Elementary School/MI and Junior High School/MTs students who were used as model schools. The technique for taking field trial subjects was done purposefully and cluster sampling. The types of data obtained from product trials are of two kinds, namely qualitative and quantitative data. Qualitative data are in the form of input from experts. Quantitative data in the form of responses of students' answers (scores) to the tests tested on them. The instruments used in this trial were observation sheets, questionnaires, and tests. Observation sheet to find out the implementation of the learning model, teacher activities, and students. The questionnaire was addressed to the teacher to determine the suitability of the material with student development, readability of the learning scenario, and the suitability of the test with the learning objectives. The questionnaire was also addressed to students, namely to determine the readability of teaching materials and questions. The test is developed in the form of multiple choices, with 4 choices of answers, and descriptions. analytical techniques used to answer research problems. Analysis of the validity of the model developed by descriptive qualitative. Analysis of empirical test data using percentage descriptive statistics, the effectiveness of the model was analyzed through improving student learning...
outcomes using normalized gain factors whose significance were tested by parametric statistical tests using t-test.

3. Results and Discussion

Each stage of research produces outputs: (1) results of dissemination (2) natural disaster learning tools integrated into a SETS vision of natural science, (3) results of expert validation of learning devices developed, and (4) increasing teacher and student understanding of natural disasters integrated into a SETS vision of natural science. The dissemination of the natural disaster learning model with SETS vision integration in natural science subjects in the community, which had been obtained in the previous year, was carried out through seminar activities and implementation in schools. Disseminate results in the form of scientific papers and teaching materials that have been validated based on empirical data on implementation activities in schools. The results of giving questionnaires to elementary and junior high school science teachers who are members of the Semarang City Science KKG and MGMP show that they need an integrated natural disaster learning model in natural science by SETS vision. Most teachers agree that natural disaster learning is delivered in an integrated manner in science lessons, because it makes it easier for students to understand the concept of disaster, without having to add new subjects. They realize that they are still experiencing difficulties when teaching natural disaster integrated into natural science subjects. Therefore, they welcomed the learning tools that can be used to teach natural disasters that are integrated into science. Based on the results of curriculum analysts and theoretical studies, a natural disaster learning model integrated into the natural science was chosen which could be developed with SETS vision. The feature of the SETS vision learning model that is integrated into natural science subjects has been produced. The learning tools include (a) Syllabus, (b) Lesson Plan (RPP), (c) Teaching Materials, and (d) Evaluation Assessment.

Development of this learning tool through workshops with several elementary and junior high school teachers. The five features of the model developed are packaged in the Textbook for Students and the Teacher's Manual.

Validation of the features of the learning model developed was carried out by experts and practitioners in the field. For the purposes of validation, an assessment tool has been prepared. This instrument was through expert review before being used as a data retrieval tool. For the purposes of validation, an assessment tool has been prepared. This instrument was through expert review before being used as a data retrieval tool. Some input from experts and practitioners was used to revise the instruments developed. The validated instrument is then used to assess each model feature that has been compiled by researchers and teachers in the field. Expert inputs are used as a basis for improving learning tools that have been developed, and guidelines for developing five model features for different themes. Not all learning devices have been evaluated by experts, given the limited time and number of products produced. Products that have been implemented can be seen in Table 1.

| Themes / Topics of Teaching Materials | Class | Testing School |
|--------------------------------------|-------|----------------|
| Plant Root Structure and Its Function | IV    | SDN 5 Gajahmungkur Semarang |
| Adapting plants to their environment | V     | SDN 5 Gajahmungkur Semarang |
| Weathering                           | VI    | SDN 5 Gajahmungkur Semarang |
| Stages of Human Development in Relation to Natural Disasters | VII  | SMPN 30 Semarang |
| Teaching Materials for Physics in Relation to Natural Floods and Landslides. | VIII | MTs Al Hidayah Semarang |
| Human Survival in Relations with Natural Disasters | IX   | SMPN 30 Semarang |

The implementation results show that the model developed is suitable for understanding natural disaster material and can improve teacher understanding of the natural disaster learning model integrated into a SETS vision of natural science, as well as increasing students' understanding of natural disasters. Improved learning outcomes show significant results. This can be seen from the large
normalized gain of student learning outcomes. In summary the gain of learning outcomes is presented in Table 2.

**Table 2. Gain Normalized Student Learning Outcomes**

| Themes / Topics of Teaching Materials | Pre-test Score | Post-test Score | Gain | Category |
|--------------------------------------|----------------|----------------|------|----------|
| Plant Root Structure and Its Function | 34,45          | 79,55          | 0,688| Moderate |
| Adapting plants to their environment | 41,00          | 80,00          | 0,661| Moderate |
| Weathering                          | 45,90          | 82,93          | 0,684| Moderate |
| Stages of Human Development in Relation to Natural Disasters | 40,00          | 72,08          | 0,535| Moderate |
| Teaching Materials for Physics in Relation to Natural Floods and Landslides. | 42,55          | 82,11          | 0,689| Moderate |
| Human Survival in Relations with Natural Disasters | 47,70          | 86,00          | 0,803| High     |

Achievement of learning objectives is determined from the acquisition of each individual score ≥ 65 and the percentage of classical completeness is ≥ 85% of students have achieved a score of ≥ 65. The results of the analysis of learning outcomes data indicate that student learning outcomes have reached a minimum score of 65 and the number of students who have achieved scores as much as 85%. In summary, the results of the t-test on student learning outcomes are presented in Table 3.

**Table 3. T-Test Results and Achievement of Learning Outcomes**

| Themes / Topics of Teaching Materials | t hitung | t table α=0,05 | Information | % Achievement |
|--------------------------------------|----------|----------------|-------------|---------------|
| Plant Root Structure and Its Function | 10,171   | 2,074          | Significant | 100           |
| Adapting plants to their environment | 9,494    | 2,060          | Significant | 100           |
| Weathering                          | 20,414   | 2,045          | Significant | 100           |
| Stages of Human Development in Relation to Natural Disasters | 3,054 | 2,021          | Significant | 60            |
| Teaching Materials for Physics in Relation to Natural Floods and Landslides. | 8,794 | 2,025          | Significant | 95            |
| Human Survival in Relations with Natural Disasters | 15,842 | 2,021          | Significant | 100           |

Analysis of learning outcomes data shows that student learning outcomes have reached a minimum score of 65. Classical achievement shows that almost all classes have reached the set limits, 85% of students have achieved a minimum score of 65. Only class VIII with material on Natural Disasters in Relation to human growth and development that has not reached 85%. Classical completeness for this class is only 60%. This result is in accordance with the results of research conducted by several researchers. Ernst & Monroe concluded that environment-based learning can improve students’ critical thinking skills and help them be more precise in solving environmental problems [11]. Research by Kim & Roth shows that the application of learning by linking science, technology, environment and society will make students better, namely the attitude of students more concerned with the environment [12]. Frank & BarBarzilai in his study showed that 95% of students argued that if the concept of SETS was included in the learning process, it gave them the opportunity to gain knowledge and enhance their understanding of the branches of science [13]. The research of Lee & Erdogan shows that there is an increase in interest in learning in the class applied by the STS approach [14]. The results research of Masfuah’s, et al, concluded that natural disaster learning with models exchanging SETS vision pairs can foster critical thinking skills and students’ caring attitudes towards disasters [15]. Thus, in general, the natural disaster learning model is integrated into a SETS vision of science developed in research This is suitable to be applied in schools, elementary and junior high schools. The existence of this learning model is expected to contribute to natural disaster mitigation through education.
4. Conclusion

The characteristics of the syllabus, RPP, and teaching material developed to refer to the SETS model. In this model, science/disaster material is associated with environment, technology, and society. The format and systemic syllabus are prepared based on the principle of oriented competence achievement for the benefit of developing SETS vision learning. The results of the analysis show that the developed lesson plans are easy to implement and disaster material is given in the appropriate proportions. Teaching materials can be obtained from various sources, the internet, books, the environment, and others. The results of the trial show that the readability of teaching materials developed is in the easy-to-understand category. The form of assessment technique used to determine the success of landslides and floods is in the form of objective questions, and descriptions. In the problem description, students are given pictures related to the disaster, students are asked to analyze according to SETS demands.

Tools that are developed valid, and effective for increasing students' understanding of disaster. This can be seen from the results of tests obtained by students. The increase in student learning outcomes (gain) from pretest to posttest ranged from 53.5% to 80.3%. For schools in disaster-prone areas, you should provide insight into natural disasters to students. Disaster material does not have to be a separate subject, but it is sufficiently integrated into other subjects, one of which is science. Teachers are expected to be more creative and innovative in teaching natural disasters, not only integrating them in science subjects but also through Indonesian, Social Sciences, Religion and Civics. The learning model used can also be varied, so that students do not get bored and try student-centered learning. Disaster learning does not stop at preventive measures, but must introduce ways of handling post-disaster. In general, the integrated natural disaster learning model in the SETS vision of natural science courses developed in this study is suitable to be applied in schools, elementary and junior high schools. The existence of this learning model is expected to contribute to natural disaster mitigation through education.

5. References

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