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DEVELOPMENT OF SCIENCE SUBJECT-SPECIFIC PEDAGOGY TO SUPPORT DISASTER RISK REDUCTION IN EDUCATION: ITS FEASIBILITY AND INFLUENCE

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Abstract
This research is aimed to (1) produce science subject-specific pedagogy based on discovery learning integrated volcanic eruption disaster consisting of syllabus, lesson plan, student worksheet, and handouts according to experts and learning practitioners, and (2) know the effectiveness of the influence of science subject-specific pedagogy based on discovery learning integrated volcanic eruption disaster to improve mastery concept and disaster preparedness in mitigation. This was a research and development (R&D). The research and development used a 4-D model which consists of four stages define, design, develop, and disseminate. The data were collected through (1) Tests, using mastery concept questions and disaster preparedness questions, and (2) Non-tests, using product feasibility assessment instruments filled by experts and learning practitioners and disaster preparedness questionnaires. Data analysis was performed by: (1) Analysis of the feasibility and validity of the Science Subject Specific Pedagogy through the validation of experts and learning practitioners categorized according to the classification of product evaluation categories, and (2) Analysis of research results using descriptive statistical analysis of gain score calculation and inferential statistical analysis of ANOVA multivariate test (MANOVA) using the SPSS 22.0 program. The results of this research and development show that: (1) the Feasibility of science subject-specific pedagogy based on discovery learning integrated volcanic eruption disaster that has been developed, according to expert and learning practitioner assessments are in the category of very good, and (2) The influence of science subject-specific pedagogy based on discovery learning integrated with volcanic eruption disasters is effective to improve mastery concept and students' preparedness in disaster mitigation.

Keywords: science subject-specific pedagogy, disaster risk reduction, student's mastery concept, disaster preparedness

INTRODUCTION

Indonesia is one of the regions with the highest volcanic potential in the world (Verstappen, 2013). One of the most active volcanoes in Indonesia is Mount Merapi. Mount Merapi with an altitude of 2968 meters above sea level is in the areas of Sleman Regency, Magelang Regency, Boyolali Regency, and Klaten Regency. The zones affected by the eruption of the Merapi volcano in Sleman Regency are spread over four areas including Ngemplak District, Turi District, Pakem District, and Cangkringan District (Badan Nasional Penanggulangan Bencana, 2011).

Most of the area around Mount Merapi is a residential area, but there is still a green area as a National Park and there are also several rivers that are upstream on Mount Merapi. Residents in the area around Mount Merapi work as farmers, sand miners, and perpetrators of lava tour attractions. The high risk of disaster should be directly proportional to the level of vigilance of the population, given the location of the volcano which is adjacent to the residential population. However, in reality, not all residents in the area around the volcano understand what to do if natural phenomena occur related to volcanic eruptions. This is indicated by when there is an increase in status, residents continue to carry out their activities as usual and tend to ignore natural signs that should be wary of.

Indonesia is a country with the fifth largest population in the world, but the knowledge and actions of Indonesian people have not been able to reflect the behavior of people who have high preparedness for disaster risk (Hidayati, 2012). Indonesian people have low performance in disaster management, low attention and focus on disaster mitigation activities, and the still weak role of education in the introduction of disaster mitigation (Dwiningrum et al., 2017). The importance of increasing understanding of disaster risk must be instilled in all components of society, including school-age children. For school-age children, education can be an effective means of learning about disaster and their risks by including subject matter on natural disasters as mandatory lessons for every student, especially in schools in disaster-risk areas (Suarmika & Utama, 2017).

Integrating disaster learning into the curriculum, it can form a spiritual attitude about the role of religion in understanding the causes of natural phenomena. In addition to spiritual attitudes, social attitudes such as caring, the importance of protecting the environment, discipline, and interaction with the surrounding environment will also be formed. Knowledge can also be formed due to various factors, such as the relationship between family, peers, school, and environmental influences. This can affect the formation of student knowledge (Selby & Kagawa, 2012).

Natural Sciences is a collection of knowledge about natural phenomena that are arranged systematically. Science objects include the universe and its contents. Science is a branch of science that studies natural phenomena and phenomena that often occur in everyday life. One example of a natural phenomenon in science is volcanic eruption. Science learning at the secondary education level should be presented holistically, but in reality, science learning cannot be implemented in an

integrated manner because it is still taught separately from each other. The availability of integrated teaching materials is needed to support integrated science learning activities in junior high schools. Teaching materials in integrated science learning have not been developed based on related materials by integrated basic competencies. Integrated science teaching materials are needed so that science learning can occur in an integrated manner. The reality in the field is very far from the understanding of integrated science. Science teachers teach all physics, chemistry, and biology subjects without connecting the three as a form of cohesiveness.t

To support integrated science learning, science subject-specific pedagogy is needed, a learning tool that can facilitate the implementation of integrated science learning, no longer being disaggregated between physics, chemistry, and biology. Thus, students can comprehensively understand science. As a follow-up, various learning needs to be developed that can facilitate the integration of disaster learning at the school level, bearing in mind that schools are formal educational institutions in the community. It is intended to give students an understanding of the natural phenomena of volcanoes and an attitude of being alert in implementing disaster mitigation. Based on the description above, the development of science subject-specific pedagogy that can facilitate the implementation of learning that integrates disaster education is deemed necessary, with the development of these devices, it is hoped that it can improve the understanding of concepts, and the preparedness of students, especially in the implementation of disaster mitigation.

METHODS

This research was a research and development (R&D). The research and development used a 4-D model which consists of four stages define, design, develop, and disseminate (Thiagarajan et al., 1974). The science subject-specific pedagogy consists of a syllabus, lesson plan, student worksheet, and handout. The feasibility of the developed science subject-specific pedagogy is assessed based on the results of the assessment of learning experts and learning practitioners using the product feasibility assessment sheet. The assessment data for each aspect and indicator of the assessment items that have been assessed by learning experts are arranged in a table then the average score is calculated using the following formula:

$$Average\ Score = \frac{Number\ of\ Scores}{Number\ of\ Validators} \quad (1)$$

The average score obtained is then classified into the following level of categories:

Table 1. Product Rating Category Classification (Widoyoko, 2017)

No	Average Interval Score	Category
1	$3.25 < x \leq 4.00$	*Very good*
2	$2.50 < x \leq 3.25$	*Good*
3	$1.75 < x \leq 2.50$	*Low*
4	$1.00 < x \leq 1.75$	*Very low*

After the developed product is assessed by an expert, the learning device product is implemented in learning to find out the effectiveness of the use of the product to increase mastery of concepts and student preparedness. The implementation was carried out in two pilot classes, where one class used the Science Subject Specific Pedagogy which was developed while the other class used the Science Subject Specific Pedagogy in the school, then the measurement of mastery of concepts and preparedness before and after learning used questions and questionnaires. The data obtained is then processed using descriptive statistics to find out the increase in gain score. The gain score categories obtained are as follows.

Table 2. Gain Score-Category (Hake, 2002)

No	Gain Score	Category
1	(⟨g⟩) ≤0,3	Low
2	0,3 < (⟨g⟩) ≤0,7	Moderate
3	(⟨g⟩) > 0,7	High

After obtaining an increase in gain score data, an inferential statistical analysis was carried out using the Anova Multivariate test using the SPSS 22.0 program to determine the effect of the use of science subject-specific pedagogy based on discovery learning integrated volcanic eruption disaster on mastery of concepts and disaster preparedness.

RESULTS AND DISCUSSION

The feasibility of the syllabus, lesson plans, student worksheets, and handouts was assessed by two learning experts and three learning practitioners. The results of the product feasibility assessment by learning experts and learning practitioners are as follows:

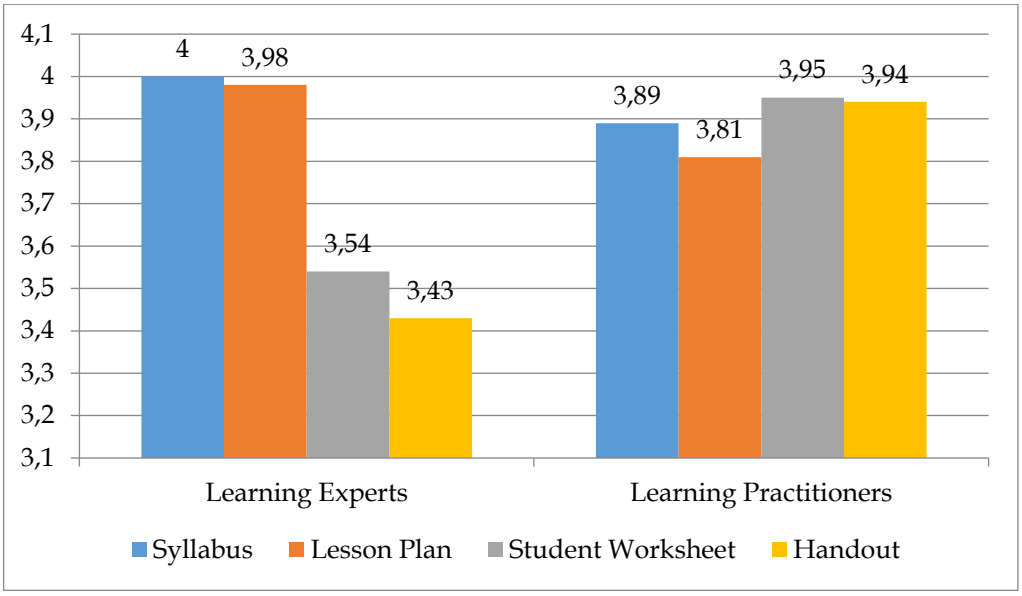

Figure 1. Product feasibility assessment chart

Overall, based on the above results, it is known that the products developed obtain a feasibility assessment from learning experts and learning practitioners with very good categories and are suitable to use in the learning process.

Concept mastery is measured using multiple choice questions totaling 35 numbers given before and after learning. The results obtained are then analyzed descriptively using Microsoft Excel which is then categorized according to the gain score increase category. The results of the assessment of the mastery of the concept of the experimental class and the control class in the assessment before and after treatment are as follows:

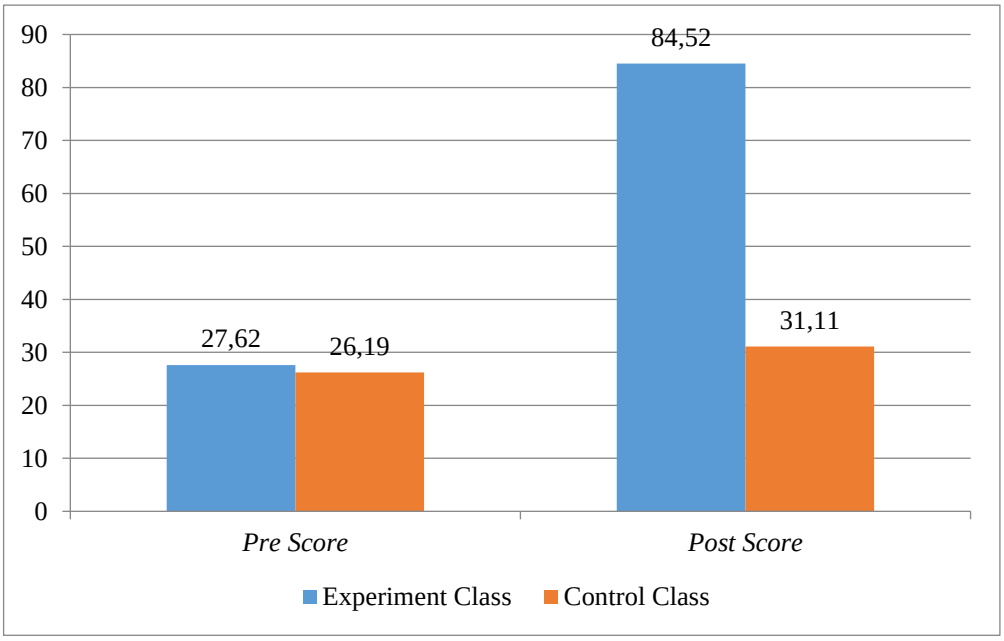

Figure 2. Assessment of students' mastery concepts

Based on the gain score analysis that has been done previously and from the graph above, it is known that the increase in mastery of the concept of experimental class using the science subject specific pedagogy based on integrated discovery learning based on volcanic eruption disaster is very significant compared to the control class using the science subject specific pedagogy from school.

Mastery of students' concepts can be increased through learning that stimulates thinking and intellectual abilities. The use of teaching materials can help increase students' mastery of concepts (Syar, 2017). The experimental class that obtained material from the handout experienced a very significant increase in scores compared to the control class that did not use handouts. This shows the handout to be one of the product that has an influence in improving students' mastery of concepts.

Discovery-based science learning is very demanding of student activity, so that it can indirectly train improved cognitive, affective, and psychomotor aspects. The syntax contained in the discovery learning model requires students to be actively involved in every learning activity so that students not only listen to the teacher's explanation but also explore understanding and find their knowledge independently (Limbong et al., 2019).

One of the factors that encourages students' ability to understand the concept of learning is discussion and practicum activities (Kumullah et al., 2018). That is

because students are given the freedom to solve their own problems through group discussions. The teacher only acts as a facilitator who provides feedback and input on concepts that have been discovered by students themselves. Besides that, the existence of a phenomenon that is inherent in daily life, students are able to stimulate the development of their thinking skills in problem solving, so students will get a deeper understanding (Marlina et al., 2017; Rini & Aldila, 2023).

Preparedness is measured using questions and questionnaires given before and after learning as well as preparedness observation sheets on the implementation of unplanned simulations as supporting data. The results obtained are then weighted to obtain the final score and then analyzed descriptively using Microsoft Excel which is then categorized according to the category of gain increase. The results of the preparedness assessment of the experimental class and the control class in the assessment before and after treatment are as follows:

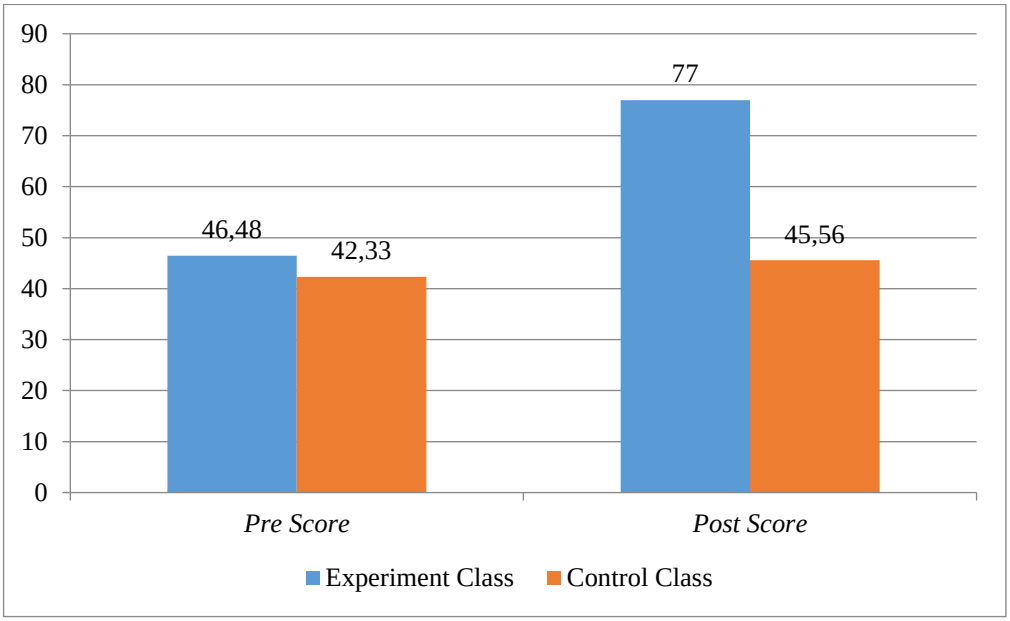

Figure 3. Assessment of students' preparedness

Based on the results of the gain score analysis that has been done previously and from the graph above, it is known that the increase in the preparedness of experimental class students using the science subject specific pedagogy based on integrated learning volcanic eruption disaster is very significant compared to the control class that does not use the science subject specific pedagogy. Measured aspects of preparedness are knowledge and attitudes towards disaster risk, early warning systems, plans for disaster emergencies, and resource mobilization.

Schools are one of the communities that are vulnerable to disasters, therefore, efforts to improve community-based disaster management programs need to be done in schools, one of which is with the participation of students in carrying out disaster risk reduction activities that are integrated in teaching and learning activities in schools (Astuti & Yuliyanto, 2015). Science is a very appropriate subject

considering that disaster is a natural phenomenon that can cause damage and endanger life (Almukarramah et al., 2013).

Students of SMP N 2 Cangkringan who mostly live in disaster-prone areas also indirectly have provisions and resilience in the face of volcanic eruption disasters. This is evidenced by the still thick nuances of local wisdom and the customs of the people of the slopes of Mount Merapi. Citizens are not at all eroded by the flow of modernization and continue to heed the local wisdom that they trust. However, local wisdom is not directly taught by parents to their children so it is possible that this attitude naturally arises in accordance with the environment in the area (Widodo & Hastuti, 2019).

Supporting this cases, need tools that support the implementation of disaster education at the formal education level in order to direct the knowledge and understanding that students have previously had, of course, this can be facilitated by the science subject specific pedagogy based on discovery learning integrated the volcano eruption disaster that has been developed. The use of specific learning tools integrated with disaster education can direct students directly to the attitude of preparedness that must be possessed.

Multivariate test aims to determine whether there is a significant difference from the gain score of process skills, mastery of concepts, and preparedness together both in the experimental class and the control class. The levene's value for each variable is 0,981 for concept mastery and 0,419 for disaster preparedness. It states that the data is ready to analyze with multivariate test. Multivariate test results are as follows:

Table 1. Multivariate Test Analysis Result

Effect		Value
Science	Pillai's Trace	0,923
Subject	Wilks' Lambda	0,077
Specific	Hotelling Trace	12,055
Pedagogy	Roys' Largest Root	12,055

Based on the four results of the analysis it can be seen that the influence of the independent variable on the dependent variable is getting greater. The significance values for the four analyzes are 0,000. The significance level is set at 0.05 so that the significance value is smaller, then hypotheses in this study is accepted, which means that there are significant differences in the concept mastery and preparedness in disaster mitigation between students participating in learning using the learning science Subject specific pedagogy based on discovery learning integrated volcano eruption disaster with students participating in learning without using the product developed.

Students' preparedness to face a volcanic eruption disaster can be realized if all aspects of learning competence are trained, both aspects of knowledge (cognitive), attitude (affective), as well as skills or psychomotor (Fitrissani et al., 2014). The strategy of integrating disaster education in schools prone to disasters with appropriate learning models is very effective in increasing students' preparedness for natural disasters (Septikasari & Ayriza, 2018). In addition, the use of media in the form of real objects by bringing students to objects directly, in this case learning is

carried out using objects that are attached to the daily lives of students who are facilitated with appropriate learning media, it is also very effective in increasing student preparedness (Amaliya et al., 2011).

Science subject specific pedagogy based on discovery learning integrated with the volcano eruption that was developed facilitates the three domains of competence, where when students have the skills in this process skills in participating in learning activities, it will improve the mastery of the concept. Improved concept mastery will have an impact on the formation of a good preparedness attitude for students.

CONCLUSION

The results of this research and development shows that: (1) Feasibility of Science Subject Specific Pedagogy based on discovery learning integrated volcanic eruption disaster to improve mastery concept and disaster preparedness in mitigation that has been developed, according to expert and learning practitioner assessments are in the category of very good, and (2) The influence of Science Subject Specific Pedagogy based on discovery learning integrated with volcanic eruption disasters is effective to improve mastery concept and students' preparedness in disaster mitigation.

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