13 (3) (2024) 293-304

Unnes Science Education Journal

Accredited Sinta 2

https://journal.unnes.ac.id/journals/usej

Effectiveness of Disaster Adaptation and Mitigation Comics to Improving Disaster Response Literacy of Senior High School Students Through Problem-Based Learning Model Based on Wonosobo Local Potential

Sumardi Sumardi✉, Sri Ngabekti, Sigit Saptono

DOI: http://dx.doi.org/10.15294/usej.v13i1.10598

Universitas Negeri Semarang, Indonesia

Article Info

Submitted 2024-10-28
Revised 2024-11-13
Accepted 2024-12-30

Keywords

Disaster Literacy; Problem Based Learning; Local Potential Wonosobo

Abstract

This research aims to test implementability, effectiveness, describe the characteristics of the Wonosobo local potential-based disaster adaptation and mitigation comics developed. The devices developed are syllabus, lesson plans, and teaching materials in the form of comics. The research sample for the limited scale trial was 10 X grade students using purposive sampling technique. The research population in a wide-scale trial with a Pretest-postest control group design, class X.1 as an experimental class of 30 students and class X.2 as a control class of 31 students. The results showed that the Wonosobo local potential-based disaster adaptation and mitigation comic was suitable for use. The increase in learning outcomes (N-Gain) in the experimental class of 60% is in the medium category or the N-gain interpretation category is quite effective. Based on the achievement of KKM, 97% of students reached the set KKM of 68. The conclusion in this study is that the Wonosobo local potential-based disaster adaptation and mitigation comics developed are declared very valid, very good implementation, and effective for use in learning activities on environmental change material. The characteristics of the Wonosobo local potential-based disaster adaptation and mitigation comics developed present data, photos of disaster events and environmental damage in Wonosobo Regency, so that the Problem Based Learning (PBL) learning model can be carried out optimally. Comics of disaster adaptation and mitigation based on Wonosobo local potential are recommended to be used by Biology Teachers in Wonosobo Regency in learning environmental change material.

How to Cite

Sumardi, S., Ngabekti, S., & Saptono, S. (2024). Effectiveness of Disaster Adaptation and Mitigation Comics to Improving Disaster Response Literacy of Senior High School Students Through Problem-Based Learning Model Based on Wonosobo Local Potential. *Unnes Science Education Journal*, 13(3), 293-304

✉ Correspondence Author:
E-mail: mardisam2019@gmail.com

p-ISSN 2252-6617
e-ISSN 2502-6232

INTRODUCTION

The large number of casualties, property losses and damage to building infrastructure and the environment indicate the low level of community preparation and preparedness in the face of disasters (National Disaster Management Agency, 2023). The number of casualties during a disaster is influenced by a lack of knowledge and awareness of the impact of disasters. Community preparedness to face potential disasters in high-risk areas of earthquake and tsunami disasters is needed to minimise the consequences, both in terms of casualties and property (Adri et al., 2020).

Efforts can be made to instil early community awareness of disaster adaptation and mitigation knowledge through learning in education. According to Zunariyah et al. (2019) empowering children in disaster mitigation is the first step in building a disaster-aware society. One example is disaster mitigation in the Disaster Safe Education Unit scheme. In real life, institution-based disaster risk reduction has made a concrete contribution. The role of educational institutions in disaster risk reduction has been integrated in science lessons. Even disaster issues have become mainstream in the curriculum of educational institutions in some schools (Rubaidi, 2018).

Disaster education can be carried out through integration with various subjects, especially science. Disaster education is becoming increasingly urgent along with the increase in disaster events due to climate change, the fact that Indonesian students' disaster literacy is low, and the uneven disaster education provided by the government (Aroyandini et al., 2023). The existence of natural disasters and environmental damage that occurs in Wonosobo Regency, as well as efforts to prevent or reduce disaster risk through adaptation and mitigation measures need effective communication strategies by conveying messages through the development of printed teaching materials in the form of comics. Comics are an art form that is popular especially among children, thus it can be utilised as a potential medium for education (Tatalovic, 2009). While Vasilikopoulou et al. (2006) stated that the power of comics in education is enormous and the added value of digital hypermedia comics is that almost all students and teachers gave positive responses. The implications for teaching in the future appear that comics have clear value as an innovative tool. The creation of comics always involves students in providing a great introduction, guidance, and inspiration for using comics as a pedagogical tool (Bessette, 2020). The results of the study Phoon et al., (2020) show that the use of comics is very interesting and fun for students and has a positive impact in supporting science learning.

By looking at the real environmental damage problems that exist in Wonosobo Regency, a suitable learning model is needed, namely Problem Based learning (PBL). Azis et al. (2021) in their research concluded that disaster mitigation learning is very suitable to be taught with the Problem Based Learning model, students are able to solve problems in their environment, trained to think critically in an effort to analyse disasters, their impacts and lead to solving disaster mitigation problems. This learning model has proven effective in encouraging learners' competence in directing themselves to collaborative learning, thinking critically, being able to self-reflect and overcome new problems (Manwa et al., 2013).

Through PBL learning, it is expected that students can have the ability to solve environmental damage problems in the Wonosobo Regency area. However, unfortunately, learning environmental damage with the PBL model has not integrated knowledge to students about disaster response awareness through adaptation and mitigation steps. Mitigation is expected to be able to reduce or minimise the impact caused to the community and the environment, can be done through slope stabilization by means of vegetative engineering (Rendra et al., 2016).

Meanwhile, environmental damage to local potential in Wonosobo Regency is not widely known by students. Based on the data obtained through the distribution of questionnaires with a sample of 30 students of class X.1 who have studied environmental damage material, 96% of students do not know about environmental damage to local potential in Wonosobo. Teachers and students do not use the local environment as a learning resource. Learning environmental damage material with the PBL model has not integrated knowledge to students about disaster response awareness through adaptation and mitigation steps. The teaching materials used by teachers and students are Biology books published by the government and other relevant books published from outside. On the other hand, from a sample of 30 students in class X.1, 100% of students have not been able to link the concept of environmental damage with local potential in Wonosobo.

The reality in the field of learning environmental damage material so far has not utilised local potential based on the results of the questionnaire, 100% of teachers stated that teachers agree with the appointment of local potential as

a learning resource. Teachers have never applied Wonosobo local potential-based disaster adaptation and mitigation comic media in learning activities, and there are no Wonosobo local potential-based disaster adaptation and mitigation comics developed by schools.

The results of a survey to the Wonosobo Regency BPBD (Regional Disaster Management Agency) office, obtained information that the media for socialisation to the community has been through the official website of the Wonosobo Regency BPBD which contains modules or disaster books in general, disaster maps of Wonosobo Regency which are scattered in each sub-district, installation of banners in disaster-prone areas/ areas in each sub-district, and training and socialisation activities between the BPBD of Central Java Province and the Wonosobo Regency BPBD regarding the identification of disaster-prone areas. Interesting, effective and efficient learning requires the development of innovative teaching materials (Ditendik, 2008).

To encourage and motivate learning with the PBL model of environmental damage based on local potential to be more interesting, if it is packaged through the development of teaching materials in the form of comics. Comics allow long and complicated explanations of a topic to be more easily understood and remembered by students (Handayani and Koeswanti, 2020). Research Suratsih et al., (2010) that local potential owned by schools and areas around schools has not been utilised optimally in biology learning activities, biology teachers have not worked much to develop biology teaching materials based on local potential. This research aims to test the 1) implementability, 2) effectiveness, 3) describe the characteristics of the Wonosobo local potential-based disaster adaptation and mitigation comics developed.

METHOD

This research begins with an analysis of the potential and problems used as the basis for needs analysis, namely the high disaster-prone areas and losses caused by environmental damage and the absence of teaching materials that integrate disaster events in Wonosobo Regency into Biology subject matter. The development of comic design for disaster adaptation and mitigation based on Wonosobo's local potential begins with analysing KI-KD, determining comic titles, preparing materials, learning sequences and comic structures. In addition to making comic designs, comic development instruments were also prepared, such as syllabus, lesson plans, comic validation sheets for education experts, material and media experts, response questionnaires about comics for students and teachers, learning outcomes test questions to measure the effectiveness of comics. The comic design developed was then validated by education, material and media experts. The validated comics were tested on a limited scale on 10 grade X students. Limited scale trials to obtain information on the readability of the comics developed. Wide-scale testing with purposive sampling technique. The research population in a wide-scale trial with a pretest-postest control group design, class X.1 as an experimental class of 30 students and class X.2 as a control class of 31 students. The data and data sources in this study are presented in Table 1.

Table 1. Data and Sources of Research Data

No	Data and Data Sources	Type of Data	Data Source
1	Validity of learning tools (Syllabus, lesson plans, teaching materials in the form of comics, LDPD, Evaluation Questions)	Quantitative	Education and materials expert
2	Implementation in learning (observation by teacher observers and student activities)	Quantitative	Learners and teachers
3	Learning outcomes a. Knowledge aspect b. Attitude aspect c. Skill Aspect	Quantitative	Learners
4	Descriptive Characteristics of Comics	Qualitative	Data and documentation of disaster events and environmental damage in Wonosobo

The effectiveness of comics is seen from the completeness of learning outcomes in the aspects of knowledge, attitudes and skills of students. The knowledge aspect is done by using a test. Quantitative data processing was carried out using statistical tests on the results of pretest,

posttest, and N-Gain data for the experimental class. Assessment of learning outcomes in the attitudinal aspects of disaster response literacy and students' skills in making disaster posters was calculated using a modified formula from Sudijono (2009).

RESULTS AND DISCUSSION

Needs for Development of Disaster Adaptation and Mitigation Comics

The importance of developing comics of disaster adaptation and mitigation based on Wonosobo's local potential is based on the analysis of needs in the field. Based on the results of distributing questionnaires to Biology teachers who are members of the Wonosobo Regency Biology Teacher Consultation (MGMP), it is explained that there are no Wonosobo local potential-based disaster adaptation and mitigation comics developed at school as teaching materials. This is supported by the results of filling out a questionnaire from students who have studied environmental change material in grade 10, that Biology teachers at SMA Muhammadiyah Wonosobo have never used or applied Wonosobo local potential-based disaster adaptation and mitigation comics in learning environmental change material.

The absence of Wonosobo local potential-based disaster adaptation and mitigation comics developed as teaching materials, shows a lack of inventory of local potential that can be raised as Biology teaching materials. Teachers do not have the opportunity to enrich the analysis of Biology learning materials by exploring local potential sources in their area. Teachers and students do not use the local environment as a learning resource, as a result students do not know much about environmental problems based on the local potential of Wonosobo Regency, as well as the lack of awareness and real action from teachers and students in preserving local potential through education.

Students argue that although environmental change material is easy to learn, learning environmental change material so far does not integrate knowledge and foster awareness to students about disaster response awareness through disaster adaptation and mitigation measures based on Wonosobo's local potential. Biology teaching materials used by teachers have been in the form of modules, material summaries equipped with Learner Worksheets (LKPD) used for their own circles, and books from the government or independent school procurement, so that the material taught is still general.

The analysis of Wonosobo's local potential which is the basis for the development of disaster adaptation and mitigation comics in the form of environmental damage to forest resources in the Sindoro Mountain area, the Serayu River watershed which is converted unwisely into an excavation - C mining area and the expansion of protected forest areas by the community in the Dieng Plateau area of Wonosobo Regency for monoculture crop agriculture (potatoes), causing land degradation. The presence of geothermal wells used for power generation (PLTP), and several tourist attractions in the form of active craters, is a local potential of Wonosobo that must always be watched out for its existence. The proximity of settlements and agricultural areas to these dangerous areas can be a serious threat, especially the danger of crater eruptions that can occur at any time, followed by the release of toxic gases from soil fractures in the area.

Implementation of Disaster Adaptation and Mitigation Comic Use in Learning

The Wonosobo local potential-based disaster adaptation and mitigation comics that have been validated and revised are then tested on a limited scale to determine the level of readability and practicality in learning activities. Learner responses can be seen in Table 3.

Table 3. The results of students' and teachers' responses to disaster adaptation and mitigation comics based on Wonosobo's local potential

No	Type of Data	Percentage (%)	Category
1.	Learners' responses on the limited scale trial	82 %	Good
2.	Learners' responses on the wide-scale trial	88%	Very good
3.	Teacher feedback	88 %	Very good

The trial of Wonosobo local potential-based disaster adaptation and mitigation comics on a limited scale obtained responses from students with a percentage of 82% (good category). Learners feel happy and interested in the existence of teaching materials in the form of disaster adaptation and mitigation comics based on Wonosobo's local potential. The appearance of the cover of disaster adaptation and mitigation comics on a limited scale trial obtained the lowest

score of 65%. Disaster adaptation and mitigation comics are then made improvements and revisions to the cover in order to become better disaster adaptation and mitigation comics.

The wide-scale trial of Wonosobo local potential-based disaster adaptation and mitigation comics obtained responses from students with a percentage of 88% (very good category). Teacher responses obtained a percentage of 88% (very good category). The development of disaster adaptation and mitigation comics based on Wonosobo's local potential really helps make it easier for teachers to understand environmental damage material so that comics can be used by teachers in teaching in class.

Analysis of the implementation of the use of comics of adaptation and mitigation of disasters based on Wonosobo's local potential in learning is done by calculating the percentage of the syntax of the Problem Based Learning (PBL) learning model that is implemented during the learning process by the teacher, including three phases of learning, namely the initial activity, core activity and closing activity. The recapitulation of the observation results by the observer teacher can be see in Table 4.

Table 4. Recapitulation of teacher observation results and student activity observations on the implementation of the use of disaster adaptation and mitigation comics in learning

No	Type of Data	Percentage (%)	Category
1.	Teacher observation results on the implementation of the use of adaptation and mitigation comics in learning	88 %	Very Good
2.	Observation results of students' activities	93 %	Very Good

Teacher observations on the implementation of the use of Wonosobo local potential-based disaster adaptation and mitigation comics in learning were carried out by the observer teacher as an observer of classroom activities for 3 meetings. The observation results gave an average score of 35 out of 40 with a percentage of 88% in the very good category. This means that during the learning process activities carried out by the teacher using disaster adaptation and mitigation comics based on Wonosobo's local potential are appropriate and very well implemented.

Observation of students' activities on the implementation of the use of Wonosobo local potential-based disaster adaptation and mitigation comics uses a learning implementation activity sheet with 10 statement items carried out during learning. This sheet was filled in by the researcher himself who acted as a teacher in class X.1 (experimental). The activities of students on the implementation of the use of comics in learning are presented in Table 5.

Table 5. Activities of experimental class students on the implementation of the use of comics in learning

Class	Category			
	Very Good	Good	Enough	Less
Exsperiment	53.3 %	40 %	6.7%	0%
Control	0 %	32.5 %	37.5 %	30%

The results of the assessment of learner activity on the implementation of the use of Wonosobo local potential-based disaster adaptation and mitigation comics in the experimental class were better than the control class. In the experimental class, 53.3% (very good category), 40% (good category), 6.7% (sufficient category), and 0% (less category) were obtained.

Effectiveness of Disaster Adaptation and Mitigation Comics

Learning outcomes in the knowledge aspect are taken from the post-test score of disaster response literacy on environmental change material. Based on the recapitulation of the N-gain measurement results, the assessment of the knowledge aspect between the experimental class and the control class based on the N-gain interpretation is presented in Figure 1.

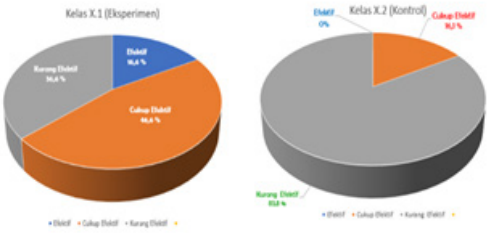

Figure 1. Recapitulation of knowledge aspect assessment between experimental and control classes based on N-gain interpretation (■ effective, ■ effective enough, and ■ effective less).

The results of the N-gain test measurement

on the assessment of the knowledge aspect show that in class X.1 (experimental) there are 16.6% or 17% of students who get N-gain in the effective category, 46.6% or 47% of students who get N-gain in the moderately effective category, and 36.6% or 37% of students who get N-gain in the less effective category, whereas class X.2 (control) there were 0% of students who got N-gain in the effective category, 16.1% or 16% of students who got N-gain in the moderately effective category, and 83.8% or 84% of students who got N-gain in the less effective category. In general, the experimental class is better than the control class.

To see the effectiveness of the use of Wonosobo local potential-based disaster adaptation and mitigation comics in learning by looking at the average score for the experimental class pretest and posttest data in the N-gain Score test as presented in Table 6.

Table 6. N-gain Score Test Results Pretest and Posttest Value Data

Class Data	N	Average		Category
		N-Gain	N-gain Score	
Experiment	30	59.86	60%	Moderately Effective
Control	31	42.28	42%	Less Effective

Based on the results of the N-gain Score Test on the data of the pretest and posttest scores of the experimental class, namely 59.86 or 60%, this shows that the use of Wonosobo local potential-based disaster adaptation and mitigation comics is in the medium category or the N-gain interpretation category is quite effective. From these data, it shows that there is a difference in the posttest results of classes that learn to use disaster adaptation and mitigation comics based on Wonosobo local potential with classes whose learning does not use disaster adaptation and mitigation comics based on Wonosobo local potential.

Hypothesis testing must meet the requirements of homogeneous and normal data. The homogeneity of the data can be seen from the normality test value of 0.200 For the homogeneity test result of 0.757 which indicates that the data is homogeneous, so that it can use the T test. Thus there is a significant difference between the control class and the experimental class (the Wonosobo local potential-based disaster adaptation and mitigation comic developed is effective).

The development of disaster adaptation and mitigation comics based on Wonosobo's local potential is effective if the learning outcomes of the knowledge aspect ≥ 75% of students get a completeness score above the Minimum Completeness Criteria (KKM) which is 68. The results of data recapitulation obtained 97% or as many as 29 students were declared complete from a total of 30 students in the experimental class.

The learning outcomes of the attitude aspect assessment were taken through a questionnaire assessment of the attitude aspect of disaster response literacy, filled in by students after completing the lesson. The questionnaire consists of 20 statement items with four answer categories, namely 1) Strongly Agree (SS), 2) Agree (S), 3) Disagree (KS), 4) Disagree (TS). The maximum score of this questionnaire is 80. The questionnaire was filled in by 30 students in the experimental class, and 31 students in the control class. The results of the recapitulation of the assessment of the attitude aspects of experimental and control class students are presented in Table 7.

Table 7. Recapitulation of the assessment of the attitude aspects of experimental and control class students

Class	Category			
	Very Good	Good	Enough	Less
Exsperiment	46.6 %	50 %	3.4%	0%
Control	25.8%	45 %	30 %	0%

The recapitulation of the assessment of the attitudinal aspects of disaster response literacy shows that in general, experimental class students have good (50%) and very good (46.6%) disaster response literacy attitudes. Learning outcomes of skill aspect assessment are taken through observing the skills of students in making disaster posters. The recapitulation of students' skill scores between experimental and control classes is presented in Table 8.

Tabel 8. Recapitulation of the assessment of the skill aspects of experimental and control class students

Class	Category			
	Very Good	Good	Enough	Less
Exsperiment	32 %	58,0 %	10 %	0 %
Control	16,2 %	51,6%	32,2 %	0 %

Characteristics of the Developed Disaster Adaptation and Mitigation Comic

The comics developed are comics of disaster adaptation and mitigation based on Wonosobo's local potential. The activity begins with reviewing the design of disaster adaptation and mitigation comics based on Wonosobo's local potential by analysing KI-KD, determining comic titles, backgrounds and story ideas, creating storylines, creating character characters, sketching panel layouts, illustrations, and text balloons, colouring pictures, making and filling text balloons, compiling page layouts, front and back covers and printing comics. In developing disaster adaptation and mitigation comics based on Wonosobo's local potential, other research tools were also prepared in the form of syllabus, lesson plans, evaluation tools with their grids, student discussion sheets, observation sheets, questionnaire sheets, validation sheets for each research tool (material validation, media validation). Disaster adaptation and mitigation comics are designed with illustrations of disaster stories or events caused by environmental damage that occurs in the Wonosobo Regency area. The characters that appear in the comic storyline of disaster adaptation and mitigation are taken as a form of representation from all circles of society such as students, employees as well as volunteers from the Wonosobo Regency Regional Disaster Management Agency (BPBD), village officials, Search and Rescue Teams, police, scientists and experts from the Centre for Volcanology and Geological Disaster Mitigation (PVMBG), with the aim of strengthening and increasing disaster literacy contained in the comic storyline of disaster adaptation and mitigation for high school students.

The development of disaster adaptation and mitigation comics based on Wonosobo's local potential is designed according to the syntax of the Problem Based Learning (PBL) learning model as a learning resource in student discussion activities on environmental change material. The design of the lesson plan is 4 meetings with a duration of 3 hours each lesson. At the beginning of meetings 1 and 2, students are presented with data on disaster events in Wonosobo Regency in 2015-2021, 2001-2015 land use data in the Dieng Plateau of Wonosobo Regency, data from the final report of the Wonosobo Regency Environment and Forestry Service in 2016 on the study of environmental damage due to mineral and coal mining, and images of environmental damage to Wonosobo's local potential through presentation and discussion activities. In meeting 3, learners are presented with the video 'Sinila Crater Tragedy, 20 February 1979' and the Metro TV show 'Against Forgetting the Grief Story of Sinila' through presentation and discussion activities. In meeting 4, learners make posters about disaster preparedness efforts due to local environmental damage and analyse the problem solving that has been found in the disaster poster presentation.

DISCUSSION

The importance of developing comics of disaster adaptation and mitigation based on Wonosobo's local potential is based on the analysis of needs in the field. Based on the results of distributing questionnaires to Biology teachers who are members of the Wonosobo Regency Biology Teacher Consultation (MGMP), it is explained that there are no Wonosobo local potential-based disaster adaptation and mitigation comics developed at school as teaching materials. This is supported by the results of filling out a questionnaire from students who have studied environmental change material in grade 10, that Biology teachers at SMA Muhammadiyah Wonosobo have never used or applied Wonosobo local potential-based disaster adaptation and mitigation comics in learning environmental change material.

The absence of Wonosobo local potential-based disaster adaptation and mitigation comics developed as teaching materials, shows a lack of inventory of local potential that can be raised as Biology teaching materials. Teachers do not have the opportunity to enrich the analysis of Biology learning materials by exploring local potential sources in their area. Teachers and students do not use the local environment as a learning resource, as a result students do not know much about environmental problems based on the local potential of Wonosobo Regency, as well as the lack of awareness and real action from teachers and students in preserving local potential through education.

The use of Biology teaching materials is still general in nature causing the local context not to be conveyed in the learning process, so there is no local potential of Wonosobo developed as teaching materials. This is in accordance with the results of research by Suratsih et al. (2010) that the local potential of schools and areas around schools has not been utilised optimally in biology learning activities, biology teachers have not worked much to develop biology teaching materials based on local potential. It is important for teachers to utilise local potential in learning because it

helps students understand concepts and examples that are contextual and able to improve the knowledge, skills and attitudes of students (Nisa, 202 2).

Validation of the development of Wonosobo local potential-based disaster adaptation and mitigation comics was carried out by educational experts, material experts and media experts, with the aim of knowing the feasibility of the developed disaster adaptation and mitigation comics. Based on the results of the validation of Wonosobo local potential-based disaster adaptation and mitigation comics by educational experts, material experts and media experts, the comics developed obtained an average percentage of 90%, with a very valid category for use in learning, the Wonosobo local potential-based disaster adaptation and mitigation comics developed have fulfilled the elements of development from the aspects of education, material and media, which at first comics were only entertainment and fiction, but along with the development of society, new comic categories emerged that were able to have educational elements in them such as education, information facts, and so on.

The stages of developing disaster adaptation and mitigation comics based on Wonosobo's local potential are revised to get a better product in terms of exposure to educational aspects, materials and media. Revisions were made after getting suggestions and input from validators of education, material and media experts. Revisions were made to the syllabus for input, suggestions for improvement from educational expert validators because there were still components that had not been fulfilled, namely the comic media developed had not appeared in the syllabus section. By including Wonosobo local potential-based disaster adaptation and mitigation comics into the syllabus section, especially in the media column, teaching tools or materials, and improving the part of learning activities, especially the description of each syntax to include comics as a discussion material for students. The revision of the Learning Implementation Plan (RPP) component was carried out because there were still notes of improvement from the education expert validator, namely by clarifying the use of Wonosobo local potential-based disaster adaptation and mitigation comics in the learning syntax of the PBL model. The use of developed comics in each learning syntax of the PBL model acts as teaching material or a source of information to answer questions contained in the student discussion sheet during class discussion activities.

The components in the comic according to the three material expert validators that need to be revised are emphasising the need to form disaster clusters such as public kitchens, health service posts, and the installation of refugee tents. For the display of comics, the colours are tried to be brighter. The purpose of establishing clusters in order to facilitate the implementation of disaster management tasks of the National Disaster Management Agency (BNPB) or Regional Disaster Management Agency (BPBD), it is stipulated based on the Decree of the Head of BNPB Number 173 of 2014 concerning national disaster management clusters including health clusters, search and rescue, logistics, refuge and protection, economic clusters, and infrastructure facilities. Another revised component is that the colour display of comics as teaching materials is very important and necessary in comic design. Colour objectively/physically according to Brewster in Poeng (2022) is the nature of the light emitted while subjectively/psychologically it is part of the human visual sensory experience. Colour can also influence the interpretation of meaning in terms of emotions, symbols and philosophy as a form of colour psychology.

The results of the limited scale trial of Wonosobo local potential-based disaster adaptation and mitigation comics obtained responses from students with a percentage of 82% (good category). From the results of the limited scale trial, there is the lowest value statement item with a percentage of 65% (poor category), namely the cover of the comic with a colour display that is too dark. Improvements to the cover are made to get a brighter and more attractive colour display. Students feel happy and interested in the existence of teaching materials in the form of comics of disaster adaptation and mitigation based on Wonosobo's local potential because this is the first time they have taken Biology lessons with teaching materials that are different from usual. The ease and entertaining effect on comics make comics favoured by students (Herbst et al., 2011). Comics that are liked by students are comics whose language is straightforward, clear, and simple (Maulani and Hidayati, 2021).

The results of the broad-scale trial obtained responses from students with a percentage of 88% (very good category). Learners feel happy and interested in comic teaching materials for adaptation and mitigation of disasters based on Wonosobo's local potential, because comics are not too thick, practical and easy to carry, can help make it easier to understand environmental damage material, the language used in this comic is simple, communicative and easy to understand,

contains important knowledge about efforts to adapt and mitigate disasters due to environmental damage based on Wonosobo's local potential, contains messages and values on efforts to preserve Wonosobo's local potential, so that it can be used by teachers in teaching in class or used by students to learn independently.

Teacher responses obtained a percentage of 88% (very good category). The development of Wonosobo local potential-based disaster adaptation and mitigation comics really helps make it easier for teachers to understand environmental damage material so that comics can be used by teachers in teaching in class. According to Gunawan and Sujarwo (2022) comics can be used as a medium in transferring material from teachers to students. Comic media can be used to stimulate students visually, these stimuli help increase student motivation in learning. Lo et al., (2022) in their research stated that comics are the preferred media by many children in schools, and comics attract more students to visit the library.

Teacher observations on the implementation of the use of Wonosobo local potential-based disaster adaptation and mitigation comics in Problem Based Learning model learning, carried out by the teacher observer as an observer of classroom activities for 3 meetings. The observation results gave an average score of 35 out of 40 with a percentage of 88% in the very good category. While the observation of students' activities on the use of comics of adaptation and mitigation of local potential-based Wonosobo disasters using the activity sheet of learning implementation with 10 statement items carried out during learning. This sheet was filled in by the researcher himself who acted as a teacher. The assessment results showed that the experimental class was better than the control class. Learners in the experimental class as a whole obtained an average score of 37 out of 40 with an assessment in the good and very good category of 93.3%.

The implementation of the use of Wonosobo local potential-based disaster adaptation and mitigation comics during the Problem Based Learning (PBL) model learning process received an excellent assessment. This shows the consistency of teachers and students in using comics in each syntax as a source of information that can contribute and build ideas in answering all problems related to disasters in Wonosobo Regency, which are contained in the students' discussion sheet in the form of leading questions that must be resolved during discussion activities, and it is hoped that students can improve their critical thinking skills so that they can find alternative solutions.

The learning outcomes of students in this study were obtained through the assessment of aspects of knowledge, disaster response literacy attitudes, and skills. The results of the N-gain Score Test of the pretest and posttest data of the experimental class, namely 59.86 or 60%, indicate that the use of comics for disaster adaptation and mitigation based on Wonosobo's local potential is in the medium category or the N-gain interpretation category is quite effective, compared to the control class of 42.28 or 42% in the less effective category. Based on the reference Minimum Completeness Criteria (KKM) set at 68, 97% of students were declared complete, namely 29 students out of a total of 30 students from the experimental class, so that the development of disaster adaptation and mitigation comics based on Wonosobo's local potential met the criteria for the effectiveness of their use in the experimental class.

The results of the assessment of the attitudinal aspects of disaster response literacy showed that in general the experimental class students had good (50%) and very good (46.6%) disaster response literacy attitudes with an overall result of 96.6% compared to the control class. The acquisition of a score with a percentage of 96.6% or 97% with an excellent category in the experimental class, shows an understanding of disaster response is very good. The attitudinal aspect of disaster response literacy involves measuring or building students' knowledge capacity on disaster issues. Efforts to increase knowledge about disaster response to students continue to be carried out continuously. Habituation to disaster response needs to be integrated in learning so that learners are skilled in disaster adaptation and mitigation efforts in the Wonosobo Regency area. Disaster literacy develops morals in a skill in the event of a disaster (Zhang et al., 2021).

The learning outcomes of the assessment of the skills aspect are taken through observing the skills of students in making disaster posters. shows that in general the experimental class students. The achievement obtained by the experimental class obtained a score with a percentage (58.0%) of the good category and a percentage (33.3%) of the very good category with an overall result with a percentage of 91.3% of the very good category. The excellent results obtained by the experimental class on the assessment of the skills aspect in making disaster posters because students read and study carefully the instructions for making disaster posters before learning activities begin, students bring complete

tools and materials independently and in making posters meet the four elements of the assessment category, namely innovative, clearly legible, clear message, and on time. The same thing is stated by Pauwels (2015) that a good poster must provide clear information, be able to attract attention, have retention of the message conveyed. Making disaster posters by students aims to add insight into knowledge to be better prepared to deal with disasters that can come at any time. The results of the study (Mustika et al., 2023) concluded that disaster mitigation counselling through educational posters can provide additional information on community knowledge and understanding related to earthquake disasters. In addition, it increases public awareness of actions that must be taken when a disaster occurs, as well as before and after a disaster occurs.

The development of disaster adaptation and mitigation comics based on Wonosobo's local potential is oriented towards increasing knowledge about disaster response literacy of high school students. To strengthen knowledge about disaster response literacy, it is considered necessary for the curriculum structure in education units at all levels to integrate disaster education in subjects, as research (Aroyandini et al., 2023) states that disaster education can be carried out through the integration of various subjects, especially science. This is very important because the disaster response literacy of Indonesian students is still low. The habit of disaster response literacy of students must always be improved through various developments in teaching materials (Pratiwi et al., 2020).

CONCLUSION

The Wonosobo local potential-based disaster adaptation and mitigation comics developed are declared very valid, very good implementation, and effective for use in learning activities on environmental change material. The characteristics of the Wonosobo local potential-based disaster adaptation and mitigation comics developed present data, photos of disaster events and environmental damage in Wonosobo Regency, so that the Problem Based Learning (PBL) learning model can be carried out optimally. The comics of disaster adaptation and mitigation based on Wonosobo's local potential are recommended to be used by Biology Teachers who are members of the Wonosobo Regency Biology Subject Teacher Consultation (MGMP) community in learning environmental change material.

REFERENCE

Adri, K., Rahmat, H. K., Ramadhani, R. M., Najib, A., & Priambodo, A. 2020. "Analisis Penanggulangan Bencana Alam Dan Netech Guna Membangun Ketangguhan Bencana Dan Measyarakat Berkelanjutan Di Jepang". *Nusantara: Jurnal Ilmu Pengetahuan Sosial*, 7(2), 408–420.

Aroyandini, E.N., Rusilowati, A., Supriyadi, Hartono, Retnoningsih, A., Marianti, A., Hamid, N., & Juhadi. 2023. "Urgensi dan Tantangan Mengajarkan Pendidikan Kebencanaan Melalui Pembelajaran IPA". *Prosiding Seminar Nasional Pascasarjana Universitas Negeri Semarang*: 245-253.

Azis, I.S., Sugandi, D., & Setiawan, I. 2021. "Learning of disaster mitigation through problem based learning method in senior high school". *International Geography Seminar. Series: Earth and Environmental Science 683 012053*.

Badan Nasional Penanggulangan Bencana, B. (2023). *Indeks Risiko Becana Indonesia Tahun 2022 (1st ed., Vol. 01).*

Bessette, L.S. 2020. "Teaching Comics/Teaching with Comics: A Review of With Great Power Comes Great Pedagogy: Teaching, Learning, and Comic Books". *The Comics Grid: Journal of Comics Scholarship*, 10(1): 2.

Direktorat Tenaga Kependidikan Direktorat Jenderal Peningkatan Mutu Pendidik dan Tenaga Kependidikan Departemen Pendidikan Nasional. 2008. *Media Pembelajaran dan Sumber Belajar. Materi Diklat Calon Pengawas Sekolah/ Pengawas Sekolah*. Jakarta

Gunawan, P., & Sujarwo. 2022. "Pemanfaatan Komik Sebagai Media Pembelajaran Sejarah Dalam Meningkatkan Motivasi dan Hasil Belajar Siswa". *Kronik : Journal of History Education and Historiography.* Vol. 6, No.1.

Handayani, P., & Koeswanti, H. D. 2020. "Pengembangan Media Komik Untuk Meningkatkan Minat Membaca Siswa Sekolah Dasar"". *Jurnal Basicedu*, 4(2), 396-401.

Herbst, P., Chazan, D., Chen, C. L., Chieu, V. M., & Weiss, M. 2011. "Using Comics-Based Representations of Teaching, and Technology, to Bring Practice to Teacher Education Courses". *ZDM*, 43(1), 91-103.

Juhadi, & Herlina, M. 2020. *Buku Panduan Pendidikan Literasi Mitigasi Bencana di Sekolah*. Kudus; Parist Penerbit.

Lo, P., Lyu, Y. P., Chen, J. C. chen, Lu, J. L., & Stark, A. J. 2022. "Measuring the educational value of comic books from the school librarians' perspective: A region-wide quantitative study in Taiwan". *Journal of Librarianship and Information Science*, 54(1), 16-33.

Manwa, L.NG., Bridges, S., Law, S.P., & Whitehill, T. 2013."Designing, Implementing and Evaluating an Online Problem-Based Learning (PBL) Environment – A Pilot Study". *Informa Clinical*

Linguistics & Phonetics, Early volume 28, No. 2, 117-130.

Maulani, W., & Hidayati, P. 2021. "Model Penemuan Terbimbing Dalam Pembelajaran Menulis Teks Negosiasi Berbasis Komik Dan Pengaruhnya Terhadap Kualitas Berbikir Kreatif Siswa Kelas X SMK". *Wistara: Jurnal Pendidikan Bahasa dan Sastra*, 4(1), 63-71.

Mustika, I., Afriandi, M.Z.,Nurahman, N.F., Andriani, A., Robiatul, D., & Ramdani, R.R. 2023." Penyuluhan mitigasi bencana melalui media edukasi di Desa Nagrak Kecamatan Cianjur". *Abdimas Siliwangi.* 6 (3).

Muruganantham, G. 2015. "Developing of E- Content Package by Using ADDIE model". *International Journal of Applied Research*. Vol. 1 No. 3.

Nakano, G., Suwa, S., Gautama, A., & Yamori, K. 2020. "Long-Term Evaluation of Proactive Attitudes toward Disaster Education in Nepal". *International Journal of Disaster Risk Reduction*, 50(101866), 1–12.

Nisa, W.M. 2022. "Pembelajaran Terintegrasi Polos (Potensi Lokal Sekolah) Dalam Meningkatkan Minat Belajar IPA Siswa" *Jurnal Dikdaktik Pendidikan Dasar* 6(3).

Pauwels, Luc, . 2015 . *Reframing Visual Social Science: Towards a More Visual Sociology and Anthropology*. Cambrigdge: Cambridge University Press.

Pratiwi, M., Astuti, B., Subali, B., & Nurbaiti, U. 2020. "Profil Literasi Sains Peserta Didik SMP terhadap Mitigasi Bencana Pemanasan Global di Kota Semarang". *Prosiding Seminar Nasional Fisika 6.0* (27-33).

Poeng, N.G. 2022. "Pengaruh Visual Karakter Komik Spirit Fingers Terhadap Persepsi Pembaca" *Jurnal Desain Komunikasi Visual dan Media Baru*. Vol. 4 No.2.

Prihatin, R.B. 2018. "Masyarakat Sadar Bencana: Pembelajaran dari Karo, Banjarnegara, dan Jepang". *Aspirasi*, Vol. 9 No. 5: 221-239.

Phoon, H.Y., Roslan, R., Shahrill, M., & Said, H.M. 2020. "The Role of Comics in Elementary School Science Education". *Formatif: Jurnal Ilmiah Pendidikan MIPA*, 10 (2), 67-76.

Rendra, P.P.R., Sulaksana, N., & Yoseph, B. 2016."Optimalisasi Pemanfaatan Sistem Agroforestri sebagai Bentuk Adaptasi dan Mitigasi Tanah Longsor". *Bulletin of Scientific Contribution,* Vol. 14, No. 2: 117 – 126.

Rubaidi, R. 2018. "Pengarusutamaan Pengurangan Resiko Bencana (PRB) Berbasis Kurikulum Pendidikan Agama Islam. *Al-Izzah": Jurnal Hasil-Hasil Penelitian*, 13(2), 272.

Sudijono. 2009. *Pengantar Evaluasi Pendidikan*. Jakarta: Raja Grafindo Persada.

Suratsih, 2010. *"Pengembangan Modul Pembelajaran Biologi Berbasis Potensi Lokal dalam Kerangka Implementasi KTSP SMA di Yogyakarta".* FMIPA Universitas Negeri Yogyakarta.

Tatalovic, M, 2009, "Science Comic as Tools for Science Education and Communication, A Brief, Explanatory Study". *JCOM Journal of Science Communication* Volume 08(04):1-17.

Vassilikopoulou, M., Boloudakis, M., & Reatalis, S. 2006. *From Digitised Comic Books to Digital Hypermedia Comic Books:Their Use in Education*. http://www.comicstripcreator.org/DigitalHypermedia (diunduh 26 April 2019).

Zhang, D., Zhu, X., Zhou, Z., Xu, X., Ji, X., & Gong, A. 2021. "Research on Disaster Literacy and Affecting Factors of College Students in Central China". *Disaster Med Public Health Prep*, 15(2), 216–220.

.Zunariyah, S., Demartoto, A., & Ramdhon, A. 2019. "Transformative Education Model For Disaster Resilient Child. *Humanities and Social Sciences" Reviews,* 6(3), 55– 60. https://doi.org/10.18510/hssr.2018.638