DEVELOPMENT OF STUDENTS' WORKSHEET BASED ON MULTIPLE REPRESENTATION OF ENVIRONMENTAL POLLUTION THEME FOR JUNIOR HIGH SCHOOL

By Nur Balqis Mutia

WORD COUNT 4202 TIME SUBMITTED 01-FEB-2022 11:47AM

PAPER ID 82050057

Education Journal : Journal Education Research and Development
p-ISSN : 2548-9291
e-ISSN : 2548-9399

DEVELOPMENT OF STUDENTS' WORKSHEET BASED ON MULTIPLE REPRESENTATION OF ENVIRONMENTAL POLLUTION THEME FOR JUNIOR HIGH SCHOOL

Nur Balqis Mutia [1)]
[1)] IAIN Langsa

nurbalqismutia@iainlangsa.ac.id

ABSTRACT: *This study aims to produce students' worksheet of natural science on environmental pollution material for students of class VII in junior high school that are suitable for learning activities. This study uses the research and development methods by adapting Thiagarajan model through three stages of research that includes define, design and develop. The data collection was done by using observation, interviews and validation of the expert teams. The appropriateness of students' worksheet is assessed based on aspects of the students' worksheet component, content appropriateness, presentation, graphics, language and characteristics students' worksheet based on multiple representations. The result of this research is students' worksheet based on multiple representations which have been validated by expert team that is expert lecturer, science teacher and colleague. Based on the assessment that has been done by a team of experts, students' worksheet of science learning based on multiple representations with the theme of environmental pollution categorized very well. To conclude, that students' worksheet of natural science based on multiple representation is worthy to be used in natural science learning.*

Keywords: *Students' Worksheet, Multiple Representations, Environmental Pollution*

INTRODUCTION

The national education system needs to prepare the quality of human resources who are able to compete to face the challenges of the 21st century. Efforts that can be made to prepare quality human resources are education. The government has made improvements to improve the quality of education in Indonesia. In this case, teachers have an important role so that the goals of national education can be achieved. The interaction between teachers and students is very necessary in learning activities. This is in line with Al-Tabany (2014) which states that, in essence, learning is an effort made by the teacher to teach students to achieve an expected goal. Efforts to teach students are not only in the form of interactions between teachers and students but also interactions between students and other learning sources. In addition, the success of the learning process is also determined by the learning environment. Management of the learning environment must be well designed in order to develop the various knowledge, abilities, skills and attitudes of students. Effective learning focuses on learning activities that can direct the achievement of learning objectives (Yuliana, et al., 2017).

One of the efforts that can be made to achieve learning objectives is to use teaching materials that are in accordance with the needs of students. The use of teaching materials allows students to be able to learn a competency coherently and systematically

so that students are able to master all competencies in a comprehensive and integrated manner (Majid, 2011). Students' worksheet are one of the teaching materials that can support learning activities (Harahap, et al., 2020). The functions of students' worksheet are to help students carry out learning well (Kusumaningrum and Djukri, 2016). Students' worksheet is a learning resource that can be developed and compiled by teachers according to the conditions and situations of learning activities to be faced (Rohaeti, et al., 2009). Students' worksheet can be used as a guide for students in observation, experimentation, and demonstration activities to facilitate the process of investigating or solving a problem (Utami, et al., 2016). The use of students' worksheet is very important to build students' knowledge because students' worksheet is also a tool in learning activities (Sari and Agil, 2016).

Natural science is known as knowledge obtained through data collection, experimentation, observation and deduction to produce an explanation of a reliable phenomenon (Trianto, 2012). Natural science is also a systematic and holistic science, not a separate science between chemistry, physics and biology (Anjarsari, 2013). Natural science is developed as an integrative science subject that is application-oriented, developing thinking skills, learning abilities, curiosity, and developing a caring and responsible attitude towards the social and natural environment. As we know by natural science can help humans understand themselves and also the nature around them (Setiawati, 2013). Natural science learning also directs students to be able to compare the results of students' predictions with theory through experiments using scientific methods.

Science learning objectives can be achieved by implementing learning based on multiple representation. Multiple representations are a way of expressing a concept in various forms (Arifin and Anwar, 2015). These concepts can be represented in a variety of different formats, including verbal, graphical and numerical (Waldrip, et al., 2006). Learning with multiple representations can build students' self-confidence through the form of representation they choose, students also do not lose self-confidence and do not feel inferior in providing explanations for their answers (Hutagaol, 2013). Multiple representatios based learning model was developed by Sunyono (2014) with the orientation, exploration-imagination, internalization and evaluation phases. The main features of this multiple representations based learning model are collaborative, cooperative and imaginative. Through multiple representations, students can develop thinking skills and abilities that must be possessed in science learning. According to Ainsworth (1999) multiple representations have three main functions, namely to provide representations that contain complementary information or help complete cognitive processes, to limit the possibility of misinterpretation of using other representations and to encourage students to build an understanding of situation.

Environmental pollution is one of the themes of science learning in junior high school. As we know, human life can never be separated from the surrounding

environment. Humans also contribute in the formation and destruction of ecosystems on the earth. The role of humans in preserving and protecting the environment is necessary in order to create a safe and comfortable living environment. Increasing population growth and decreasing planted land greatly affect the current environmental conditions. The Sub Directorate of Environmental Statistics (2013) also explained that the increase in population will have an impact on the environment and nature. The increasing number of population affects the need for more resources such as the need for water, food, minerals, energy and the availability of land for agriculture and settlement. This can result in worsening environmental conditions due to the large amount of pollution to soil, water and air.

The results of observations and interviews that have been conducted at SMP Negeri 3 Langsa City that science learning activities are still carried out conventionally and are teacher centered. The use of teaching materials is only limited to textbooks, so that learning activities become very monotonous and tedious. In addition, if you look at the conditions of the classroom and school, there are still many students who throw the trash in table drawers or under chairs. This indicates the lack of concern of students for the environment around them. The lack of curiosity of students is also seen when many students are not enthusiastic when learning science. This is because there are still many teachers who have difficulty developing teaching materials according to the needs of students. In fact, so that learning activities can run effectively and pleasantly, additional supporting teaching materials are needed (Musthofa, 2020).

One of the efforts that can be made by the teacher so that students can be actively involved in learning activities is by using students' worksheet. The students' worksheet function as an alternative for teachers to direct teaching as teaching and learning activities. The students' worksheet can also help students to be more active in learning activities. The use of students' worksheet can also increase learning motivation and curiosity (Widjayanti, 2008). Based on research conducted by Sutamiati, Sunyono & Efkar (2015), it is known that the use of students' worksheet based on multiple representation can increase students' confidence in their ability to perform the expected actions. If students have confidence in their abilities, students can prepare themselves to learn well so that it can affect student learning achievement. Astuti (2013) also revealed that teaching materials using a multiple representation approach are effective in learning activities. This can be seen from the acquisition of higher learning outcomes than before using teaching materials with a multiple representation approach. Thus, it can be seen that the use students' worksheet based on multiple representation can improve student learning achievement. The increased learning achievement of students is none other than the active role of students during learning activities.

Based on the description above, this research will develop students' worksheet based on multiple representations on environmental pollution theme for junior high school. The purpose of this research is to produce students' worksheet based on multiple

representations with the theme of environmental pollution for class VII in junior high school.

METHODOLOGY

The type of this research is a research and development (R&D) research. The R&D research method is a method used to create a particular product. The product developed in this study was students' worksheet based on multiple representation of environmental pollution theme for class VII in junior high school. The procedure used in this R&D research adapts the development model of Thiagarajan with the stages of define, design, and develop. The students' worksheet was developed then tested for its feasibility by a team of experts, namely expert lecturers, science teachers and peers. The feasibility test of the students' worksheet includes the aspects of students' worksheet components, the feasibility of content, language, presentation, graphics and characteristics of students' worksheet based on multiple representations.

The subjects in this study were a team of experts to assess the feasibility of students' worksheet and class VII students of SMP Negeri 3 Langsa City. This research begins with a defining stage which aims to collect various information related to the product to be developed. The defining stage was carried out by conducting observations and interviews to analyze basic problems in the science learning process, analyzing the needs of students, detailing the tasks to be carried out by students, analyzing the science material to be delivered to students and determining learning objectives. Next, the design stage is carried out by selecting the media form and determining the format to be used. The design stage aims to design the product to be developed, students' worksheet based on multiple representations consisting of an introduction, content and cover. The final stage is the develop stage. At this stage a product has been produced that students' worksheet based on multiple representation. The resulting product has gone through revisions and advice by a team of experts. After the students' worksheet based on multiple representations was declared feasible by the expert team, then a trial was conducted on student class VII of SMP Negeri 3 Langsa City. The trial was conducted to determine the response of students to the students' worksheet based on multiple representation.

The data collection techniques used in this study were observation, interviews, validation sheets and questionnaires. Observations and interviews were carried out to obtain the necessary information at the definition stage. The validation sheet is used to obtain an assessment of the feasibility of the product being developed, that is students' worksheet based on multiple representation. Product feasibility assessment is carried out by expert lecturers, science teachers and peers. Suggestions and advice from the expert team are used to produce students' worksheet products feasible for use in science learning activities.

The data analysis technique used to determine the feasibility of the students' worksheet was qualitative descriptive analysis. The results of the assessment by a team of experts in the form of product quality data coded with a qualitative scale then converted from qualitative to quantitative values by looking for the average total score of each component of the students' worksheet assessment aspects using the formula:

$$X = \frac{\sum X}{n}$$

Information:
X = average score
∑X = total score
n = total rater

Furthermore, changing the average score into a qualitative value according to the assessment category as in Table 1 (Widoyoko, 2016).

Tabel 1. Assessment Category Criteria

No.	Score Range	Score	Category
1.	X > xi + 1,80 SBi	A	Excellent
2.	xi + 0,60 SBi <X ≤ xi + 1,80 SBi	B	Good
3.	xi - 0,60 SBi <X ≤ xi + 0,60 SBi	C	Sufficient
4.	xi - 1,80 SBi <X ≤ xi - 0,60 SBi	D	Less
5.	X < xi - 1,80 SBi	E	Very Less

Information:
X = Score achieved
xi = Average ideal score (1/2 (high ideal score + low ideal score))
SBi = Standard deviation ideal score
= (1/2) (1/3) (high ideal score – low ideal score)

The qualitative value shows the quality of the developed students' worksheet. Students' worksheet based on multiple representations is appropriate if the overall assessment results provide a minimum score with a sufficient category.

RESULT and DISCUSSION

Define

At the define stage, various information related to the product that will be developed at SMP Negeri 3 Langsa City will be collected. The accumulation of

information is carried out through observation and interviews by analyzing basic problems, analyzing the needs of students, detailing the tasks that will be carried out by students, analyzing natural science material that will be delivered to students and determining learning objectives. Based on the results of observations at SMP Negeri 3 Langsa City, it is known that the use of teaching materials in learning activities is only limited to textbooks. The lack of availability of other supporting teaching materials causes students to feel bored and busy with their own activities. Besides that, only a few students asked questions when the science lesson was taking place and many students talked with other students. The teaching materials used do not provide space for students to be able to carry out learning activities actively and effectively. Where the learning activities are expected to enable students to work together in finding a material concept. In general, students also prefer learning activities with experiments or practice. The learning environment of students is also not very well maintained. There are still a lot of rubbish scattered around the class, which indicates the lack of concern of students for their learning environment.

Based on these problems, we need another teaching material that can help students actively participate in science learning activities. The development of teaching materials in accordance with the needs of students of SMP Negeri 3 Langsa City is expected to help science learning activities become more meaningful and enjoyable.

Design

Obtaining information about the availability of teaching materials and some of the problems that occur in students of SMP Negeri 3 Langsa City at the define stage becomes one of the guidelines for designing the products to be made. The teaching materials to be developed in this research are students' worksheets based on multiple representations for junior high school.

The development of students' worksheet based on multiple representation was made by using the *Microsoft Publisher* program. The students' worksheet are designed with three main components, that are introduction, content, and closing. The introduction part consists of a cover, a preface, a table of contents, a manual for using students' worksheet, an information sheet for core competencies and basic competencies and the concept map. In the content section consists of activities that must be carried out by students. There are three activities in the content section which are sub-material of environmental pollution, that are water pollution, air pollution and soil pollution. The closing section contains a bibliography and author's biography. Bibliography contains literature used in the drafting of students' worksheet. The author's biography contains the author's curriculum vitae.

In the introduction, the cover of the students' worksheet are designed using an attractive image and is in accordance with the students' worksheet theme so that it can attract the attention of students. Preface, table of contents, a manual for using students'

worksheet and information sheet for core competencies and basic competencies are written according to a good and correct language structure according to the enhanced spelling. On the table of contents sheet, in order to make the display more attractive, an image is added that is in accordance with the sub-material to be studied by students. Information sheet for core competencies and basic competencies contains about core competencies and basic competencies in accordance with the theme of students' worksheet. The basic competency in students' worksheet that will be developed is to analyze the occurrence of environmental pollution and its impact for the ecosystem. The concept map sheet contains the relationship between the concept of environmental pollution which has a meaningful relationship with the source of pollution and the impact of environmental pollution that occurs.

In the content section, it consists of activity sheets that will be carried out by students in each sub-material. The characteristics of multiple representations are also reflected in the contents. Each activity in the students' worksheet consists of orientation, exploration-imagination, internalization and evaluation sections. In each section there are activities that must be carried out by students and teachers. The orientation section includes the activities of giving motivation and perceptions by teachers to students by displaying images in accordance with the environmental pollution phenomenon that occurs. The exploration-imagination section consists of practicum and discussion activities that must be carried out by students and guided by the teacher. In this section, students can also be trained to work together when doing practicum and answering questions at the students' worksheet. In the internalization section, it consists of activities to present the results of group discussions and individual exercises that must be done by each student. Group presentations are carried out to find out and confirm the results of the discussions that have been carried out by each group of students. Individual exercises are also useful for developing student representation skills independently. In the evaluation section, it consists of providing feedback and drawing conclusions carried out by the teacher and students. This section also adds tasks that must be done by students at home.

Develop

At the development stage, students' worksheet based on multiple representations has been validated by a team of experts and limited trials for students will be produced. After the students' worksheet is completed, an assessment is carried out by a team of experts. The expert team consists of two expert lecturers, two science teachers and two peers. The assessment of the students' worksheet feasibility criteria is a score ranging from 1 to 5. Scores are given to 6 aspects of the assessment which include the feasibility of content, language, presentation, graphics, characteristics and components of the students' worksheet.

The purpose of the assessment made by the expert team is to be able to s the students' worksheet that has been prepared according to the needs and objectives based on the results of the initial analysis at the define stage. The results assessment by a team of experts are then converted to the criteria listed in the Table. 1. Based on the results of the assessment given by the expert team, the average score of the students' worksheet based on multiple representations for each of its aspects is presented in Table 2.

Table 2. The Result Assessment of Students' Worksheet Based on Multiple Representation by The Expert Team

Aspect	Validator			Max. Mean Score	Average	Category
	Expert Lectures	Science Teachers	Peers			
Feasibility Content	17,5	18	18	20	17,83	Excellent
Language	17	18,5	19	20	18,17	Excellent
Presentation	17	18	17	20	17,33	Excellent
Graphics	18,5	19	17,5	20	18,33	Excellent
Characteristic	14	18	19	20	17,00	Excellent
Components of Students' Worksheet	50,5	55	52	55	51,83	Excellent

The results of the assessment from the expert team in Table 2 show that the results of the assessment obtained by each aspect of the feasibility of the students' worksheet get excellent category. The percentage of quality assessment results for each aspect of feasibility is presented a diagram in Figure 1.

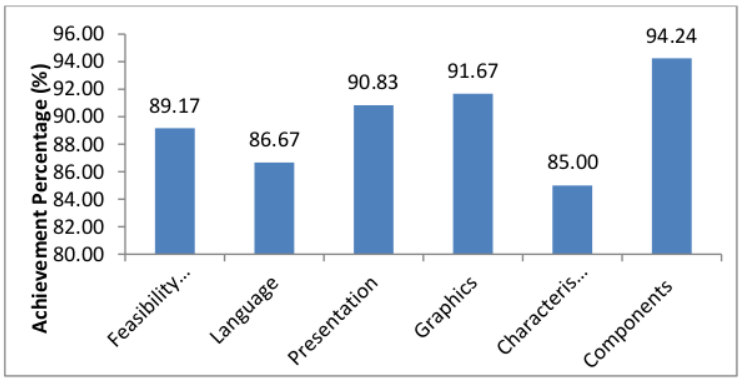

Figure 1. Students' Worksheet Quality Assessment Diagram for Each Aspect

Figure 1 shows that the students' worksheet component aspects received the highest score than other aspects with a value of 94.24% while the characteristic aspects of the students' worksheet received the lowest score with a value of 85%. Overall, students' worksheet based on multiple representations scored excellent in the category. This shows that the students' worksheet based on multiple representation is feasible for learning science class VII in junior high school.

The expert team also provided several criticisms and suggestions for perfecting the developed of students' worksheet, including: (1) the use of conjunctions in each word in the concept map; (2) changing the layout clearly and proportionally; (3) adding source information to each picture or article used in the students' worksheet; (4) revising practice activities that represent polluted conditions without killing living things; (5) adding activity objectives to each activity in the students' worksheet; (6) correcting several sentences of questions according to junior high school level; (7) using articles that are close to the students' environment.

Based on the criticism and suggestions given by the expert team, improvements were made to the development of students' worksheet based on multiple representations in relation to things that must be improved. After the students' worksheet has been repaired according to the advice of the expert team, the draft of the students' worksheet based on multiple representations is ready to be tested on students.

The Trial of Students' Worksheet

After the revised draft of students' worksheet based on multiple representations was conducted, a trial was conducted on 28 students of class VII junior high school at Langsa City. The feasibility test of the students' worksheet uses a student response questionnaire to the readability of the students' worksheet based on multiple representations. Students explore to the students' worksheet based on multiple representation and respond to the questionnaire that has been given. The average of student response assessments is presented in Table 3. The results of the questionnaire assessment showed the acquisition of a excellent response value from students.

Table 3. Recapitulation of Students' Responses

Aspect	Percentage (%)	Category
Feasibility	97,62	Excellent
Presentation	98,81	Excellent
Language	98,21	Excellent
Graphics	96,43	Excellent
Average	**97,77**	**Excellent**

Based on the result of students' responses, it can be seen that the students' worksheet based on multiple representation can attract students to learn it and is suitable for using in science learning class VII junior high school.

CONSLUSION

Based on the result of research on the development of students' worksheet based on multiple representation obtained the result of the feasibility by a team of experts showed that the students' worksheet based on multiple representation was feasible to be used in learning of science at class VII junior high school. This is also supported by the positive responses of students to students' worksheet based on multiple representation.

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