Unnes.J.Biol.Educ. 11 (2) (2022)

Journal of Biology Education

http://journal.unnes.ac.id/sju/index.php/ujbe

The Students Worksheets Based on Problem-Based Learning on Ecosystem Materials

Annisaa Nurjannah, Nana Kariada Tri Martuti[1]✉, Noor Aini Habibah[2]✉

[1]Biology Department, FMIPA, Universitas Negeri Semarang, Indonesia

Article Info

Article History:

Received: March 2021
Accepted : Juli 2021
Published : August 2022

Keywords:
based on PBL, development, ecosystem material, Students Worksheets

Abstract

An observations showed that the worksheets used in Senior High School 11 Semarang only contain a summary of the content of the material and the questions without facilitating the students' activity. In addition, the learning process had not stimulated students to solve real problems. This research aimed to analyze the validity, legibility, and effectiveness of Students Worksheets based on PBL on ecosystem material. This research was conducted at Senior High School 11 Semarang with a Research & Development (R&D) research design. The research steps included potential and problem identification, data collection, product design, design validation, design revision, small-scale trials, product revisions, large-scale trials, product revisions, and final products. Due to the Covid-19 pandemic a pre-experimental design with one-group pretest-posttest was done online. The data analysis used descriptive percentages. Students 'classical completeness was 86.11% with an increase in students' understanding of the concept of the medium category. The average percentage of students' skills competency assessment obtained very good criteria. Students responded very well in large-scale trials. Based on these results, it can be concluded that the development of Students Worksheets based PBL on ecosystem materials is feasible and effectively improve student learning outcomes.

✉ Correspondence Address:
D6 Building, First Floor, Sekaran Gunungpati Street, Semarang
E-mail: nanakariada@mail.unnes.ac.id
nooraini@mail.unnes.ac.id

p-ISSN 2252-6579
e-ISSN 2540-833X

INTRODUCTION

Rustaman et al., (2003) stated that the learning process of biology is not enough to memorize the material contained in supporting books, but rather emphasizes providing experience to develop competencies so that students can understand scientifically. Based on this, we need a lesson that can provide real experiences to students. Biological objects vary greatly so that not all materials can be presented directly with real examples. Therefore, it is necessary to use teaching materials that can be used to help students understand the material. This is following research from Wahyudi et al., (2014) which states that the use of teaching materials in the learning process can improve student learning outcomes. One alternative teaching material that can be used to support biology learning activities in schools in the Student Worksheet.

Based on the results of observations at Senior High School 11 Semarang, the Students Worksheets used is the result of the Biology Subject Teacher Conference (MGMP) in Semarang which was developed based on the 2013 curriculum that has not been revised. The Students Worksheets from the MGMP contains a summary of the content of the material and the questions so that the activities presented do not facilitate the role of students in learning to find and understand the concept of the material through instructions for activities in the Students Worksheets.

The results of several studies on Students Worksheets have had a positive impact on learning. Firanti & Paidi (2016) in their research concluded that PBL-based Students Worksheets on environmental pollution material affects students' creative and reflective thinking skills. Arafah *et al.,* (2012) show that the application of learning using Students Worksheets can improve learning outcomes and encourage students' critical thinking skills and independence.

Based on interviews conducted with biology teachers at Senior High School 11 Semarang, information was obtained that teachers used several learning methods, such as lectures and discussions. Meanwhile, the use of learning resources used by teachers in teaching and learning activities includes the use of PowerPoint, Students Worksheets, and the internet. The various methods and learning resources that have been applied have not completely resolved the problems in learning biology in schools. Learning has not stimulated students to solve real problems. Students are less faced with real problems that trigger their critical thinking.

The implementation of the 2013 revised curriculum in 2016 emphasizes a scientific approach in the learning process so that it requires teachers to apply a variety of various learning models. The learning model recommended by the government in Minister of Education and Culture Regulation Number 22 of 2016 is Problem Based Learning (PBL), Project-Based Learning (PjBL), and Discovery Learning. The view of learning curriculum 2013 is that to truly understand and be able to apply the knowledge they have, students need to be encouraged to solve problems. Increased understanding and application of knowledge to be able to solve problems at hand and problems in everyday life can be achieved with the PBL learning model.

Ecosystem material is taught to grade X even semester students. So far, students have studied ecosystem materials by memorizing and textually. Ecosystem material is closely related to real-life and many problems can be raised, for example, eutrophication events, the process of succession after volcanic eruptions, and the impact of global warming on the carbon cycle. As a result, the concepts of ecosystem material presented were still poorly understood by students, this can be seen from the daily test scores of students who obtained an average score of 67.05. Twenty-one students completed individually out of 36 students, namely those who achieved a KKM score ≥ of 70. The classical completeness achieved was 58.33%, while the expected learning outcomes could fulfill ≥75% classical completeness.

Ecosystem material was chosen because it includes material that has high complexity, is interesting to study, and requires a real application. The scope of ecosystem material includes biotic and abiotic components, interactions between ecosystem components which include interactions between species, interactions between abiotic and biotic components which include energy flow (food chains and food webs), biogeochemical cycles, ecological pyramids, and community dynamics (primary succession and secondary succession). Based on this background, the purpose of this study is to analyze the validity, legibility test, and effectiveness of the development of PBL-based Students Worksheets on ecosystem material.

RESEARCH METHODS

The research was conducted at Senior High School 11 Semarang even semester, February-April of the 2019/2020 school year. The research design uses the research and development method (Research and Development) according to Sugiyono (2016) which includes potential and problem, data collection, product design, design validation, design revision, small-scale trials, product revisions, large-scale trials, revisions product, and the final product. Small-scale trials were carried out on 10 students of class XII MIPA 5 and one teacher. Large-scale trials were carried out on 36 students of class X MIPA 6. The design of this study used a pre-experimental design in the form of a one-group pretest-posttest design. The data included the results of the validation of material expert, media expert, and biology teacher, student and teacher responses in small-scale trials, pretest-posttest scores, report-making scores, and student responses in large-scale trials. Data were analyzed using percentage descriptive analysis. Effectiveness is measured by (1) increasing understanding of the concept based on the N-gain criteria reaching a minimum of 0.31 moderate criteria, (2) classical completeness of students showing ≥75% obtaining a set KKM score of 70, (3) skill competency assessment analysis achieving a score ≥ 62.1%, and (4) the assessment of student responses on a large scale achieved a score of ≥ 62.1%.

RESULTS AND DISCUSSION

Potential And Problem

The potential in this development research is to develop Students Worksheets based on PBL on ecosystem materials. Product development potential has been held to minimize problems that occur in the classroom, i.e. there is already a Students Worksheets in use but the Students Worksheets only contain a summary of the content of the material and practice questions, so that has not facilitated students in learning activities.

Data Collection

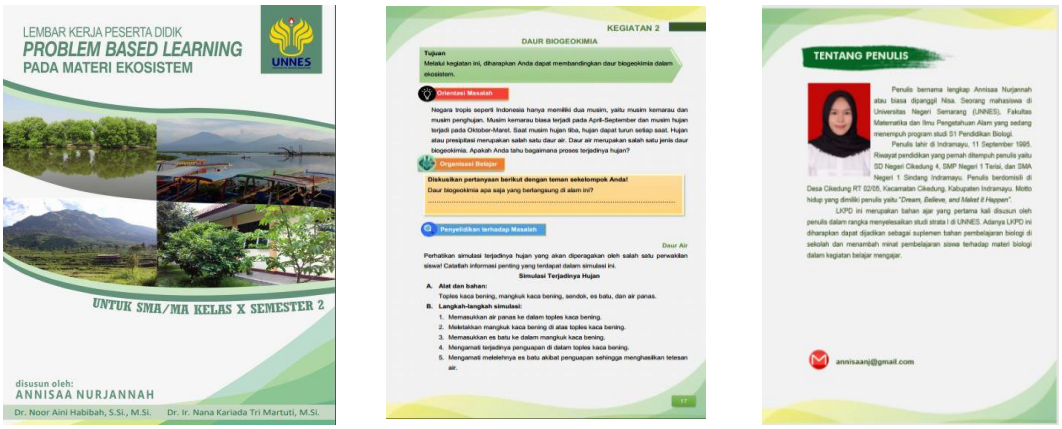
Data collection is used as material for planning certain products that are expected to overcome these problems. The data collected is in the form of materials needed for the development of Students Worksheets. The materials include ecosystem materials, basic competencies, and indicators of competency achievement based on the revised 2013 curriculum, supporting pictures and videos used in Students Worksheets as well as layout designs that are suitable for use in Students Worksheets. References for data collection come from journals, books, the internet, and news.

Product Design

The worksheet design uses Microsoft Word 2013 program to edit and merge all worksheets pages and Corel Draw X7 Graphic Suite is used to process images on vector lines. The hardware used in the development of Students Worksheets is a notebook with the following specifications: Intel Celeron Dual-Core N3050, RAM 2GB, hard disk 500 GB, 11.6 inches (1,366x768 pixels) screen, Windows 10 operating system. Students Worksheets are printed using A4 paper with CTS paper type 120 gr on the cover page and author's identity and HVS 80 gr on the content. Students Worksheets are printed in full color.

The Students Worksheets framework developed is following the modified Students Worksheets components according to the Ministry of National Education (2008**).** The introduction section consists of a cover page that reflects the contents of the Students Worksheets. The preface in the Students Worksheets is a brief introduction from the author regarding the material presented in the Students Worksheets and the expectations of the composing of the Students Worksheets. The table of contents contains information on how many pages the reader can find the material or information they are looking for. Instructions for using Students Worksheets contain instructional information that students and teachers must read in using the

Students Worksheets. The core competency, basic competency, and learning indicators contain the expected achievements in learning. The material chart contains brief information related to the material to be studied. The material introduction contains descriptions of the material. Assignments in the form of student activities are activities that must be carried out by students. The competency test contains multiple-choice questions that are done individually to determine students' knowledge abilities. The glossary contains important terms in Students Worksheets. The bibliography informs the reference sources used. The author's identity contains the name, date of birth, address, educational history, and the author's motto.



(a) (b) (c)

Figure 1 (a) Students Worksheets cover page; (b) content section; dan (c) author's identity

Design Validation

Students' Worksheets validation was conducted by a material expert lecturer, media expert lecturer, and biology teachers. Students Worksheets are assessed using the standard of teaching material eligibility according to BNSP 2014. The validity of Students Worksheets is based on the average results of material experts, media experts, and biology teachers can be seen in Figure 2.

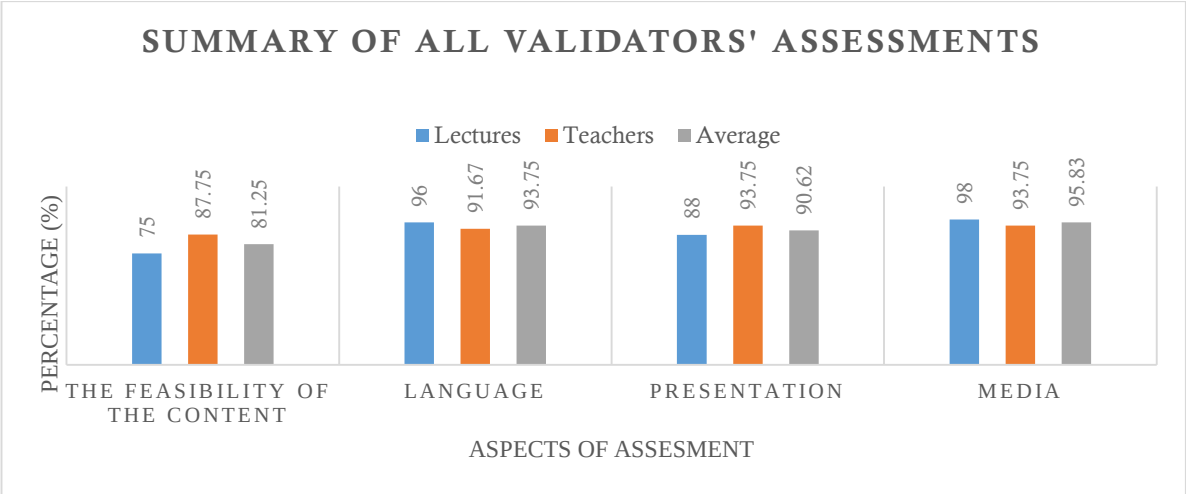


Figure 2 Diagram of a summary of all validators' assessments

Students Worksheets validation based on a summary of all validators' assessments is 90.36% with a very valid category. Based on Figure 2 shows the results that the developed Students Worksheets are suitable for use as teaching materials for the biology of ecosystem materials. The first aspect that is assessed in material validation is the aspect of the feasibility of the content (the dimension of knowledge). The aspects assessed are material accuracy and relevance to competence. The average percentage value in the content feasibility aspect given was included in the very valid category. Material accuracy is seen in the fact presented in Students Worksheets are following reality and do not have multiple interpretations. The Students Worksheets

developed are by the ecosystem material contained in the 2013 revised 2016 curriculum, namely core competency 3 and 4 also basic competency 3.10 and 4.10.

The second aspect that is assessed is language. The high percentage average indicates that the material in the development of the Students Worksheets uses language that is easy to understand, following the rules of the Indonesian language, there are real examples around students, the material and pictures presented attract students' interest, and there are discussion activities. This is in line with the research of Imtihana *et al.,* (2014) that an attractive design component is supported by a communicative and creative appearance in presenting pictures, tables, and photos that can make it easier for students to absorb learning material. In addition, the use of scientific terms, symbols, and names in Students Worksheets is consistent. Consistency aims to reduce student confusion with the material being studied during learning.

The third aspect that is assessed in material validation is a presentation which consists of presentation techniques and presentation completeness. The average percentage is included in the very valid criteria. The acquisition of a high percentage of scores indicates that the developed Students Worksheets presents coherent content of the material. The coherent presentation of the material to avoid student confusion in understanding the material. Prastowo (2012) states that the criteria for teaching materials are all materials (both information, tools, and text) that are arranged systematically, which displays a complete figure of competencies that will be mastered by students and used in the learning process with the aim of planning and studying the implementation of learning.

The next validation is media validation. The average percentage obtained from the assessment of the two validators was very high. This shows that the Students Worksheets developed are in very valid criteria when used as teaching materials. This shows that the developed Students Worksheets have an appropriate appearance as a learning resource. The developed Students Worksheets have an attractive appearance containing pictures and writing.

The size of the Students Worksheets meets ISO standards, namely using A4 paper. The elements and layout between the front and back covers have harmonious color elements, illustrations, and typography. This is supported by Hasibuan & Kartono (2013) which state that the use of color is an important element in making visual products. The use of the right color will create a beautiful image, increase readability, and increase readers' interest to see visual products.

The size of the Students Worksheets title letter on the face cover is more dominant than the author's name and the color of the Students Worksheets title letter used contrasts with the background color. The letters used in Students Worksheets are not decorative/decorative letters. This is supported by the opinion of Hasibuan & Kartono (2013), that choosing the use of letters must consider legibility rather than beauty.

The layout of the Students Worksheets content consists of the layout to accelerate the understanding and placement and appearance of the layout elements. In addition, the developed Students Worksheets have proportional content typography. The images on the Students Worksheets content are displayed, have a proportional size, and can be observed clearly. This aims to facilitate students' understanding.

Design Revision

Design revisions are made based on suggestions from the validators. Material expert provides suggestions for adding information to the contents of the Students Worksheets. It aims to complete the information in the content section. The media expert provides suggestions to improve the layout of the material chart, some questions need improvement, and competency test questions must represent all competency indicators. The layout of images and texts must be arranged proportionally so that they do not interfere with the presentation of the material. Through a proportional layout and appropriate illustrations, Students' Worksheets are expected to be well understood by students (Sitepu, 2012). Meanwhile, biology teachers suggest combining Students Worksheets with the concept of inquiry and HOTS questions. This opinion is supported by Aditama et al., (2019) which state the addition of HOTS questions in the evaluation of learning aims to make students habitual to working on HOTS questions so that students can think critically and creatively in solving problems of daily life.

Small-Scale Trials (Readability Test)

Small-scale trials are carried out to determine the results of the readability test. The readability test consisted of questionnaire data for the responses of teachers and students on a small-scale trial. The results of the questionnaire responses from small-scale trial teachers are presented in Table 1.

Table 1 The results of the questionnaire on teacher responses to Students Worksheets (small scale)

No.	Questions	Score
1.	There are core competencies, basic competencies, indicators, and learning objectives in Students Worksheets.	4
2.	Presentation of material following core competencies, basic competencies, indicators, and learning objectives in Students Worksheet.	4
3.	There are instructions for using Students Worksheets.	4
4.	Instructions for using Students Worksheets are conveyed clearly and are easy to understand.	4
5.	The presentation of ecosystem material in the Students Worksheets is arranged systematically and is easy to understand.	4
6.	Examples of pictures and problems in the Students Worksheets are following the real conditions around students.	4
7.	Student Worksheets attract students to study ecosystem material.	4
8.	The presentation of the image in Students Worksheets is clear and representative.	4
9.	Student worksheets can be used by students as a supplement to teaching materials.	4
10.	The overall appearance of the Student Worksheet is attractive.	4
	Score Total	40
	Percentage (%)	100
	Criteria	Very Good

Table 1 shows that the teacher's response to the development of Students Worksheets is very good. This is reinforced by the response from the teacher that the display content and language used are good and the developed Students Worksheets can be used as teaching material because it has met the aspects of the assessment of the feasibility of teaching materials determined by BNSP (2014). Positive teacher responses are based on indicators regarding teaching materials. The developed Students Worksheets contains KI, KD, indicators, learning objectives, and instructions for using Students Worksheets, systematic, contextual material, and the presentation of images in clear and representative Students Worksheets. This is supported by Nur's research (2012) that the selection of teaching materials in learning must consider the content of teaching materials which include the accuracy of concepts, the actuality of information, the suitability of examples, the breadth of the material, and the depth of the material. The results of the student response questionnaire are presented in Table 2 as follows.

Table 2 Recapitulation of student questionnaire responses to Students Worksheets (small scale)

No.	Questions	Total Score	Percentage (%)	Criteria
1.	The appearance of the Students Worksheet cover is attractive.	33	82.5	Very Good
2.	The instructions for using the Students Worksheet are clear and easy to understand.	31	77.5	Good
3.	The material chart in the Students Worksheet is clear and easy to understand.	30	75	Good
4.	The ecosystem material in Students Worksheet is clear and easy to understand.	32	80	Good
5.	The language used in Students Worksheet is clear and easy to understand.	35	87.5	Very Good
6.	The images presented in the Students Worksheet are clear and easy to understand.	36	90	Very Good
7.	Readability (selection of letters in Students Worksheet is appropriate so that it is easy to read).	35	87.5	Very Good
8.	Accuracy in numbering, tables, and figures.	32	80	Good

No.	Questions	Total Score	Percentage (%)	Criteria
9.	Consistency in the use of symbols/symbols.	32	80	Good
10.	The choice of color as a background for the Students Worksheet is appropriate and attractive.	35	87.5	Very Good
	Average Percentage		82.75	Very Good

Based on Table 2, the very good criteria by students indicate that the Students Worksheets developed is suitable for use as teaching material. it is known that student responses get very good criteria. Students' responses to the developed Students Worksheets reflect the ecosystem material. The developed Students Worksheets components such as cover on the face and back, instructions for using Students Worksheets, material charts, material, the language used is easy to understand, and the selection of appropriate letters so that it is easy to read In addition, the numbering of tables, figures, and use of symbols/symbols is consistent.

Product Revisions

After conducting small-scale product trials, then revisions were made to improve the products developed. The revised sections are as follows: (1) changing the cover page of the developed Students Worksheets to be more attractive; (2) improve the instructions for using Students Worksheets; (3) improve the material chart; (4) increase the images on the developed Students Worksheets. Improvements to the instructions for using Students Worksheets are carried out by changing the arrangement of the instructions for use from paragraphs to bullet points. It aims to make it easier for students to read the instructions for using Students Worksheets. This is according to Paradita and Suana's opinion (2019) which states Students Worksheets which display usage descriptions are very helpful for students by reading the usage descriptions. The added images are original images from various sources. These pictures serve as supporting illustrations to clarify the material so that it is easy for students to understand (Arsanti, 2018).

Large-Scale Trials

Large-scale trials were conducted to determine the effectiveness of Students Worksheets in learning includes the effectiveness of knowledge competency learning outcomes, skills competency learning outcomes, and student responses to Students Worksheets based PBL. Worksheets effectiveness data were collected online. This is based on a circular issued by the Minister of Education and Culture of the Republic of Indonesia on March 24, 2020, concerning the Implementation of Education Policy in an Emergency for the Spread of Corona Virus Disease (COVID-19), which states that learning in schools is done online/remotely. This is reinforced by the Circular of the Head of the Central Java Education and Culture Office Number 443.2/08991 which states that the teaching and learning process is transferred independently in their respective homes and prohibits group activities in one place. Knowledge competency learning outcomes are presented in Table 3.

Table 3 Data on student learning outcomes competency knowledge

Variables	*Pretest*	*Posttest*
Lowest Score	36	56
Highest Score	72	100
Average	58.83	82.89
Students who complete	3	31
Students who have not complete	33	5
Classical Completeness (%)	8.33	86.11

Based on Table 3, it is known that the results of the students' pretest scores on the material to be studied are still low. The low pretest scores of students can be caused by several factors, including students who have not studied and read the material before learning is carried out, understanding of the material is

still in the general scope or limited to previous levels of education, and the low interest of students in taking the tests given.

The achievement of classical completeness in this study is quite high. This is due to the quality of the pretest-posttest questions tested to students including the medium category. The test results show that the percentage of moderate questions is 64% and the percentage of difficult questions is only 12%. This shows that the questions being tested have not been thoroughly analyzed so that the level of difficulty is moderate. The medium difficulty level is usually included in C3 questions. In addition, 10 pretest-posttest questions also appear in the Students Worksheets competency test. Having the same questions on the competency test benefits students who are careful in reading the entire Students Worksheets. Students can answer the questions in the competency test first, then when the posttest is done, students only remember the questions and answers.

Then the n-gain test was carried out to determine how much the increase in student learning outcomes (pretest and posttest) in the trial class. The results of the research n-gain test are shown in Table 4.

Table 4 The results of the N-gain test in the large-scale trial class at Senior High School 11 Semarang

Criteria		**Trial Class**	
Number	**Category**	**Total Students**	**Percentage (%)**
0.71-1.00	High	13	36.11
0.30-0.70	Medium	23	63.89
0.00-0.29	Low	0	0
N-gain		**0,62**	
Category		**Medium**	

Table 4 shows that there is an increase in students' knowledge skills in the medium category. After students were treated with learning using PBL-based Students Worksheets, the lowest posttest score was still low, namely 56 and five students had not completed the KKM. This is because every student has different thinking skills so that not all students can achieve the predetermined targets. This is supported by the statement of Kurniahtunnisa (2016), that thinking is an ability that must be trained and cannot be obtained in a short time. In addition to the factors of differences in the abilities of each student, other factors affect differences in learning outcomes. First, internal factors, for example from student health, psychology, intelligence, and student activities. The two external factors, for example, the environment (home and school) as well as facilities and infrastructure that support student learning activities at school and outside of school (Slameto, 2010).

The learning process has reflected problem-solving activities. This is characterized by learning activities that begin with a problem orientation. Then, students carry out discussion activities to solve problems. Various cases taken in the development of Students Worksheets are real examples that will make students understand basic concepts, not just memorizing concepts in books so that they can improve conceptual understanding of ecosystem materials. This is supported by the research of Kono *et al.,* (2016) showing that PBL has a positive effect on students' understanding of concepts. This happens because the presentation of PBL focuses on the independence of students in exploring knowledge when solving problems that have been formulated so that students can find their answers to each problem. In addition, discussion activities in the application of PBL syntax encourage the internalization of knowledge and the development of better cooperating ability, enhancing adaptability and competitive ability in society (Lu & Lin, 2017). It is supported by Kong *et al.,* (2014) argues that PBL encourages students to become independent thinkers and supports the development of critical thinking, leadership, and teamwork. The application of online learning using Students Worksheets based on PBL utilizes google classroom. The use of google classroom has several advantages, as expressed by Iftakhar (2016), i.e. easy to use, save time, cloud-based, flexible, and free. This is a consideration that google classroom is appropriate for learning in schools.

Learning activities are carried out online, discussions are carried out through the WhatsApp group.

WhatsApp groups are used as a forum for discussion to solve various problems, questions, and something important that must be conveyed to the people who are members of it. This is following the statement of Kusuma & Hamidah (2020), discussions through the WhatsApp group help users to communicate in online learning.

Skill value data were obtained from assignments to make observation reports. The observations were carried out online and independently through an observation video of the garden ecosystem which was shared via a YouTube link. The percentage of completeness of each aspect of the assessment is presented in Table 5.

Table 5 Percentage of skills competency completeness

No.	Criterion Assessed	Total Score	Percentage (%)	Criteria
1.	Preliminary	137	95.14	Very Good
2.	Observational data	129	89.58	Very Good
3.	Discussion	130	90.28	Very Good
4.	Closing	122	84.72	Very Good
5.	Report view	122	84.72	Very Good
6.	Legibility	104	72.22	Good
	Average Percentage		86.11	Very Good

The acquisition of a high percentage of the preliminary criteria is indicated by the students writing their own identity, the title of the observation activity, the objective of the observation, the short theory, tools and materials, and complete observation steps. Meanwhile, the readability criterion obtained the lowest average percentage. This is because the ability of students to write reports is not following EYD. The results of student report corrections found that students often forget punctuation, use capital letters, and write correct words. In addition, there are errors regarding the placement of prepositions (in, to). Naturally, if there are still mistakes in the students using spelling because they are not used to using the correct one. This is supported by the statement of Dwijayanti *et al.,* (2014), that students need to be accustomed to using Indonesian according to EYD in their written language so that errors in writing can be minimized or even eliminated.

The results of the student's questionnaire responses to the development of PBL-based Students Worksheets in large-scale trials are presented in Table 6.

Table 6 Recapitulation of student questionnaire responses to Students Worksheet (large scale)

No.	Questions	Total Score	Percentage (%)	Criteria
1.	Students' Worksheet is interesting to learn.	120	83.33	Very Good
2.	The cover and contents of the Students Worksheet are attractive.	121	84.03	Very Good
3.	Instructions for using the Students Worksheet are conveyed clearly and easily understood.	124	86.11	Very Good
4.	The material in Students Worksheet is easy to understand.	121	84.03	Very Good
5.	The language used in Students Worksheet is easy to understand.	123	85.42	Very Good
6.	The pictures displayed on the Students Worksheet help me to understand the material.	130	90.28	Very Good
7.	I became motivated to learn the material in the Students Worksheet.	119	82.64	Very Good
8.	Students Worksheet adds to my insight into ecosystem material.	127	88.19	Very Good
9.	The problems presented in the Students Worksheet stimulated my curiosity.	119	82.64	Very Good
10.	Students' Worksheet helps me understand ecosystem	127	88.19	Very Good

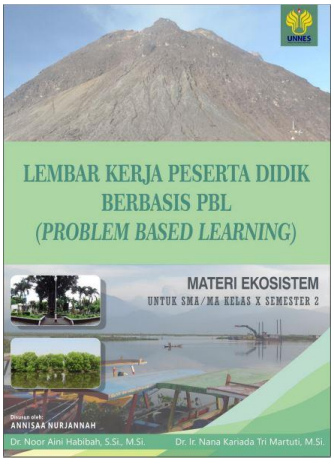
material.			
	Average Percentage	85.49	Very Good

Students gave positive responses to Students Worksheets following the recapitulation in Table 6. This shows that Students Worksheets are suitable for use as teaching materials in learning. Students give positive responses to Students Worksheets. This is based on an assessment of the aspects of the Students Worksheets usage manual, the images displayed, the material, and the language in the very good category. The instructions for using Students Worksheets are clear and easy to understand. This aims to guide students when learning (Arsanti, 2018). The image displayed on the Students Worksheets is clear and representative. Displaying pictures on teaching materials can improve student understanding. This is supported by the opinion of Utariyanti *et al.,* (2015) with the presence of pictures and explanations in the pictures, students will have an idea of what will be studied in each topic. The language used in the Students Worksheets is easy to understand so that the message to be conveyed in the Students Worksheets is easily captured and accepted by students. In addition, Students Worksheets can help students understand the material and increase students' insight about ecosystem material through the problems presented.

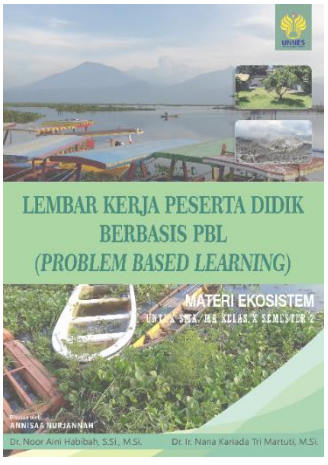
This study still faces obstacles that affect the research results. These obstacles include (1) difficulty in guiding Students Worksheets readers who experience difficulties in certain parts, (2) adjusting data collection on the effectiveness of student learning outcomes which was originally designed for face-to-face learning. Obstacles during research can be overcome in various ways, namely (1) in addition to conveying information and instructions through the tools used in learning, the teacher also provides a person in contact to students during online learning, from time to time if students experience difficulties in certain parts, (2) the teacher automatically adjusts the research data design into online research following the rules of the government.

Product Revisions

After a large-scale trial, the revision made to Students Worksheets is to improve the cover page. The parts that have been replaced are the images displayed on the cover page and their layout. Before being revised, the images displayed were pictures of Mount Merapi, Rawa Pening, school gardens, and the mangroves of Tapak Tugurejo. After being revised, the image of the Tapak Tugurejo mangrove was removed because the contents of Students Worksheets only show a glimpse of mangroves, i.e. in articles about the carbon cycle. In addition, there are no questions about the mangrove ecosystem, either in the competency test in Students Worksheets or the pretest-posttest. The image of Mount Merapi before the revision is large and placed at the very top. After being revised, the image of Mount Merapi is still placed at the top but its size is reduced. This is because the Students Worksheets developed more closely reflects the problems that exist in the province of Central Java, such as Rawa Pening



(a)



(b)

Figure 3 (a) cover page before revisions (b) cover page after revisions

The Final Product

Students Worksheets developed can be produced and used as teaching materials for 10th Senior High School. class X SMA. Furthermore, the Students Worksheets developed can be disseminated to different schools. However, in this study, it was only tested in one school and could not reach the dissemination stage due to limited time and costs.

Research Limitations

Research on the effectiveness of Students Worksheet on learning outcomes of knowledge and skills online has several limitations, including limited internet access, reduced interaction with teachers, understanding of the material is increasingly difficult with minimal interaction, and the lack of supervision of learning makes students often lose focus.

CONCLUSION

Based on the results of research and discussion, it can be concluded that Students Worksheets based on PBL on ecosystem materials that have been developed are printed teaching materials containing real problems around students such as the eutrophication of Rawa Pening and the eruption of Mount Merapi, supported by the results of a literature review from books, articles, newspapers, internet, and other reliable sources, and contain PBL syntax according to Arends (2012) on student activities. The validity of Students Worksheets based on PBL obtained very valid criteria as teaching materials based on the assessments of material experts, media experts, and biology teachers. The results of the readability test on Students Worksheets based on PBL that were developed obtained responses from biology teachers and students with very good criteria. Students Worksheets based on PBL that have been developed are effective as teaching materials.

REFERENCES

Aditama, H.S., Zainuddin, M., & Bintartik, L. (2019). Developments of Students Worksheets Based on HOTS On Mathematics Learning on Geometry Materials in 5th Grade Sentul 1 Elementary School. *Wahana Sekolah Dasar* 27(2): 66-72.

Arafah, S.F., Ridlo, S., & Priyono, B. (2012). Developments of Students Worksheets Based on Critical Thinking On Animalia Materials. *Unnes. J. Biol. Educ.,* 1(1): 47-53.

Arends, R.I. (2012). *Learning to Teach (9th ed.)*. New York: McGraw-Hill Companies, Inc.

Arsanti, M. (2018). Development of Teaching Materials for Creative Writing Courses Containing Religious Character Education Values for Students of Indonesian Language and Literature Education Study Program, Faculty of Education, Unissula. *Jurnal Kredo* 1(2): 71-90.

Dwijayanti, I.A.M.O., Suandi, I.N., & Sudiara, I.N.S. (2014). Efforts to Improve the Quality of Indonesian Language Through Analyzing Errors in Teaching Writing Students in Class VIII A Katolik Santo Paulus Singaraja Junior High School. *e-Journal Universitas Pendidikan Ganesha* 2(1).

Firanti, A., & Paidi. (2016). Development of Students Worksheets Biology Based on Problem Solving and Its Effectiveness on Creative and Reflective Thinking Skills. *Integrated Lab Journal* 4(2): 259-268.

Hasibuan, L. K., & Kartono, G. (2013). Analysis of Typography and Color Harmony in Public Service Advertisements in Medan City Year 2012. *Gorga Jurnal Seni Rupa* 1(3): 22-32.

Iftakhar, S. (2016). Google Classroom: What Works and How?. *Journal of Education and Social Sciences.* 3(Feb): 12-18.

Imtihana, M., Martin, F.P., & Priyono, B. 2014. Development of Research-Based Booklets as Learning Resources for Environmental Pollution Materials in Senior High School. *Unnes Journal of Biology Education* 3(2): 186-192.

Kong, L.N., Qin, B., Zhou, Y.Q., Mou, S.Y., & Gao H.M. (2014). The Effectiveness of Problem-Based Learning on Development of Nursing Students' Critical Thinking: A Systematic Review and Meta-Analysis. *International Journal of Nursing Students* 51(3): 458-469.

Kurniahtunnisa., Dewi, N. K., & Utami, N. R. (2016). The Influence of Problem Based Learning Model on Students' Critical Thinking Ability Excretion Material. *Unnes Journal of Biology Education* 5 (3): 310-318.

Kusuma, J.W., & Hamidah. (2020). Comparison of Mathematics Learning Outcomes with the Use of the Whatsapp Group Platform and Zoom Webinar in Online Learning During the Covid 19 Pandemic. *Jurnal Ilmiah Pendidikan Matematika* 5(1): 97-106.

Lu, H.K. & Lin, P.C. (2017). A Study of the Impact of Collaborative Problem Solving Strategies on Students Performance

of Simulation-Based Learning – A Case of Network Basic Concepts Course. *International Journal of Information and Education Technology* 7(5): 361-366.

Ministry of Education. (2008). *Development of Teaching Materials and Media*. Jakarta: Departemen Pendidikan Nasional.

Nur, F. 2012. Utilization of Learning Resources in 5th Grade Elementary School Science Learning on the Subject of Living Things and Life Processes. *Jurnal Penelitian Pendidikan*. 13(1): 67-78.

Paradita, Z., & Suana, W. (2019). Development of Student Worksheets Oriented to Higher Order Thinking Skills on Impulse and Momentum Materials. *Gravity: Jurnal Ilmiah Penelitian dan Pembelajaran Fisika* 592): 46-49.

Prastowo, A. (2012). *Creative Guide to Creating Innovative Textbooks*. Yogyakarta: DIVA Press.

Rustaman, N., Dirdjosoemarto, S., Yudianto, S.A., Achmad, Y., Subekti, R., Rochtiantaniawati, D., & Nurjhani M. (2003). *Biology Teaching and Learning Strategies.* Jakarta: Universitas Pendidikan Indonesia.

Sitepu, B. P. (2012). *Textbook Writing Lessons.* Bandung: PT. Remaja Rosdakarya.

Slameto. (2010). *Learning and Influencing Factors*. Jakarta: Rineka Cipta.

Sugiyono. (2016). *Educational Research Methods*. Bandung : Alfabeta

Utariyanti, I.F.Z., Wahyuni, S., & Zaenab, S. (2015). Development of Comic-Based Learning Media in Respiratory System Material for 8th Grade Students of MTs Muhammadiyah 1 Malang. *Jurnal Pendidikan Biologi Indonesia* 1(3): 343-355.

Wahyudi, B.S., Hariyadi, S., & Hariani, S.A. (2014). Development of Teaching Materials on the Subject of Environmental Pollution to Improve Learning Outcomes of 10th Grade Students at Grujugan Bondowoso Senior High School. *Jurnal Pancaran* 3(3): 83-92.