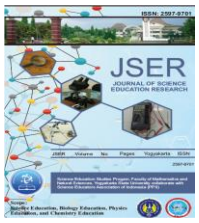
JSER

Journal of Science Education Research

Journal homepage: www.journal.uny.ac.id/jser



Development of Student Worksheet Based on Discovery Learning to Improve Students' Concept Understanding

D. Anggraini[1*], S. Susilowati[2]
[1,2] Study Program of Science Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta
Corresponding Author. Email: diananggraini.2017@student.uny.ac.id

Keywords
Student worksheet, Discovery learning, Concept understanding

Abstract
This research aimed to (1) produce student worksheet based on discovery learning to improve students' conceptual understanding, (2) analyze the practicality of student worksheet based on students' responses, and (3) test the effectiveness of student worksheet to improve students' conceptual understanding. The research used research and development (R&D) method with a 4D model. The trial design used a one-group pretest-posttest. The instruments were the eligibility validation sheet of student worksheets, student response questionnaires, observation sheets, and instrument tests. The data analysis techniques were a five-scale score conversion, implementation of the lesson plan, the percentage of the practicality of the student worksheet, Wilcoxon signed rank test, and n-Gain. The result showed that (1) student worksheet based on discovery learning was feasible to use with the result of the assessment from material and media experts in the very good category, (2) the practicality of the student worksheet was practical with a practicality percentage of 64% in a practical category, and (3) the student worksheet was effective to improve students' conceptual understanding as seen by the result of the Wilcoxon signed rank test asymp. Sig (2-tailed) 0.001 < 0.025. So, there were differences in understanding concepts before and after using the student worksheets. The result was strengthened by the n-Gain analysis of 0.4 with a medium category, and there is a significant increase in conceptual understanding.

INTRODUCTION

Science education has an important role in improving quality education, producing quality human resources, and improving the mastering of science and technology by students. The science learning process aims to enable students to have science process skills and think systematically according to scientific methods and skilled in conducting observations and experiments to solve problems (Trianto, 2014).

According to Chiapetta & Koballa (2010), the essence of science is science as a way of thinking, science as a way of investigating, science as a body of knowledge, and its interactions with technology and society. The purpose of this statement is that the nature of science consists of four aspects, namely reflecting the values and attitudes of scientists, as some processes to get to know nature, a construction of knowledge obtained through scientific activities, and the application of science in technology and society.

The context of science learning emphasizes that nature is science itself. Learning science must be a scientific process, produce scientific products, build a scientific attitude, and apply science and technology. The subject matter of science is stated in facts, concepts, principles, and laws as the result or product of science. The concept as one of the science products needs to be mastered by students to be able to solve and overcome problems in everyday life (Sulthon, 2016).

According to Nahdi *et al.* (2018), understanding concepts in science learning is very important and needs to be improved. Students who have conceptual understanding are not only limited to knowing the concepts, but students are also able to re-explain the subject matter in their own sentences and can apply it to everyday life to solve problems. Concept understanding may be improved through meaningful learning. For learning to be meaningful, it needs a lesson plan that can increase the motivation and activeness of students in the learning process. The current

learning process must be following the 2013 Curriculum. One of the things that are emphasized in the implementation of the curriculum is the use of a scientific approach. The application of a scientific approach can trigger the creation of learning experiences, facilitate students to optimize potential development, and help them achieve learning goals (Susilana, 2014).

Based on the results of observation at SMP N 1 Banguntapan, the implementation of learning using a scientific approach is still not optimal. Learning that had been done during the pandemic is still dominated by using PowerPoint and student worksheets. The learning process does not provide opportunities for students to perform contextual learning to build their knowledge.

In addition, the teaching instrument used in science learning is still informative. The student worksheet used only contains a summary of the material and answers to the question in general without activities for students. Then, student activities are dominated by memorizing material and solving the questions from the student worksheets. According to Wati & Haryati (2017), in science learning the teaching instrument should facilitate students to increase their activity, enrich experience, build knowledge, and construct a concept themselves.

These problems cause the poor students' understanding of the concept. This is indicated by the low cognitive learning outcomes of students, especially in abstract learning and memorizing. The average cognitive learning outcomes of students on memorizing have not yet reached the standard score. Only 40% - 50% of students can reach the standard score. This indicates that the understanding of students' concepts is still low. These problems are caused by the learning process that is less meaningful for students.

Based on the description of the problems, teaching instruments need to be developed to improve the motivation and activeness of students in learning. The involvement and participation of students in learning make learning more memorable and meaningful for students so it increases memory and understanding. The worksheet is an instrument to increase the students' motivation.

According to Wati & Haryati (2017) the use of worksheets in the learning process provide opportunities for students to express their abilities and skills in developing students thinking processes through the process of searching, guessing, and reasoning. One of the learning models recommended by the Ministry of Education is discovery learning. The discovery learning model is a model for developing active student learning by finding their own and investigating themselves so that results are long-lasting in memory and not easily forgotten by students. Students find the solution themselves and teachers only guide and give instructions (Fitriani *et al.*, 2017). Therefore, a study needs to be conducted in relation to the development of worksheets based on discovery learning to improve students' conceptual understanding.

RESEARCH METHOD

This research used the Research and Development (R&D) method. Research development was a process or steps to develop a new product or improve an existing product and test its effectiveness of the product (Sugiyono, 2013). The development model used a 4D model adapted from Thiagarajan (1974). This model consisted of 4 stages, namely Define, Design, Develop, and Disseminate. The 4D model can be adapted to the school's needs and its student characteristics so that it can be flexible and conditional (Wardani 2019). The research was conducted in February 2021 in SMP N 1 Banguntapan.

The subjects in this particular research were 31 students of class VIIIF of SMP N 1 Banguntapan in the second semester of the 2020/2021 school year. Determination of the sample used nonprobability sampling with purposive sampling technique. The object was worksheet based on discovery learning to improve student's concept understanding.

This research was carried out based on the steps of the 4D model, through four stages including Define, Design, Develop, and Disseminate stages. The field trial process used the pre-experimental design with a one-group pretest-posttest design. The trial design referred to Sugiyono (2013) is presented in Table 1.

Table 1. One-Group Pretest-Posttest Design

Pretest	**Treatment**	**Posttest**
O_1	X	O_2

O_1 is the pretest value before treatment; X is the treatment, i.e.: learning with worksheet, and O_2 is the posttest value after treatment. The data collection techniques were test and non-test. The quantitative data were in the form of worksheet feasibility assessment scores, lesson plan implementation scores, student response scores after using the worksheet, and pretest and posttest scores. The instruments were the worksheet feasibility assessment sheet, the lesson plan implementation observation sheet, student response questionnaires, and pretest and posttest.

The worksheet feasibility data were analyzed by calculating the average score of the results and then converted into qualitative data. Calculation of the average score used the following equation:

$$\overline{X} = \frac{\sum X}{n}, \quad (1)$$

where $\overline{X}$ is the average score of the test. $\sum x$ is total score of each component, and *n* is number of validators (Arikunto, 2010). After that, the average score was converted into qualitative data based on Widyoko (2017) given in Table 2.

Table 2. Conversion of Ideal Assessment Score

Score Range	Category
$X > \overline{X_i} + 1{,}8\,\mathrm{SBi}$	Very Good
$\overline{X_i} - 0{,}6SBi < X \leq \overline{X_i} + 1{,}8SBi$	Well
$\overline{X_i} - 0{,}6SBi < X \leq \overline{X_i} + 0{,}6SBi$	Enough
$\overline{X_i} - 1{,}8SBi < X \leq \overline{X_i} - 0{,}6SBi$	Not Enough
$X \leq \overline{X_i} - 1{,}8SBi$	Very Less

Lesson plan implementation data were obtained from learning observation sheets, which were analyzed using the *Interjudge Agreement* (IJA) equation as follows:

$$IJA = \frac{A_Y}{A_Y + A_N}, \quad (2)$$

where A_Y is activities carried out and A_N is activities that is not implemented (Arsanty, 2017). Then, the percentage of implementation was converted into qualitative data based on Table 3.

Table 3. Categories of Lesson Plan Implementation (Widyoko, 2017)

Percentage (%)	Category
> 80	Very Good
$60 < x \leq 80$	Well
$40 < x \leq 60$	Enough
$20 < x \leq 40$	Not Enough
≤ 20	Very Less

Practicality data were obtained from the results of students' responses. The data were analyzed by calculating the average of each aspect using equation (1). Then, the percentage of the practicality of student worksheets was calculated using the following equation:

$$\%R = \frac{R}{\max \text{score}} \times 100\%, \quad (3)$$

where %R is the percentage of average response value and *R* is the average response value, the *max score* is the maximum score of the test (Parawansa, 2018). Then, the percentage was converted into the criteria for the level of practicality of the student worksheet based on Parawansa (2018), which is presented in Table 4.

Table 4. Practicality Level Criteria

Score Percentage (%)	Practical Criteria
$80 \leq R \leq 100$	Very Practical
$60 \leq R \leq 79$	Practical
$40 \leq R \leq 59$	Practical Enough
$20 \leq R \leq 39$	Less Practical
$0 \leq R \leq 19$	Not Practical

Data on the effectiveness of student worksheets were obtained from the result of the pretest and posttest, which were analyzed using the Wilcoxon signed rank test and the gain score using the equation:

$$\langle g \rangle = \frac{\overline{X}\,posttest - \overline{X}\,pretest}{\overline{X} - \overline{X}\,pretest}, \quad (4)$$

where $\overline{X}\,posttest$ is the posttest value, $\overline{X}\,pretest$ is the pretest value, and $\overline{X}$ is the maximum value (Hake, 1998). The n-Gain score was then converted into a category value based on Hake (1998) and presented in Table 5.

Table 5. Category of n-*Gain* Value

n-Gain	Category
g > 0.7	High
0.7 > g ≥ 0.3	Medium
g < 0.3	Low

RESULTS AND DISCUSSION

Development Result

The development is carried out based on the stages of the 4D model. The first stage is Define, which includes initial analysis, student analysis, and goal formulation. At this stage, an interview was conducted with a natural science teacher in 8th grade of SMP N 1 Banguntapan. Based on the interview, it is found that the learning media used so far is only a book and students memorize the lesson from books. So the learning media is still less effective and efficient. In addition, problems in the use of this media have an impact on the quality of learning, which is characterized by low cognitive learning outcomes. For these reasons, a learning media needs to be developed so the learning process becomes more active and fun.

The second stage was Design. The purpose of this step is to determine the format used as a guide in the preparation of the student worksheet based on discovery learning. This stage includes the preparation of instruments selecting media, selecting the format of the teaching instrument, and making the design of the product. The article used MS Word as an application for making interactive student worksheets.

The third stage is Develop, *which* includes the validation process by the material and media experts. After that, the product was revised according to the validators' suggestions, thus the product can be tested in the learning process. The last stage in this research is Disseminate. It is the stage of distribution of the final student worksheets, which has been revised, based on the results of students' responses and science teachers. The dissemination process is also carried out by making scientific articles to be disseminated so that the benefits of the research are more optimal.

The student worksheet assessment is carried out by material and media experts using a product feasibility assessment sheet that contains aspects of feasibility of content, presentation, language, graphics, discovery learning coverage, and concept understanding indicators. The results of the student worksheet feasibility by the material experts is presented in Table 6. Based on Table 6, the results of the feasibility assessment by the material experts produce an average score of 4.26 in the very good category.

Table 6. Result of Material Expert Assessment

Aspects of assessment	Score	Category
Content Eligibility	4.2	Very good
Presentation	4.25	
Language	4.2	
Discovery Learning Coverage	4.3	
Coverage of Concept Understanding	4.3	
Average	4.26	

Table 7. Result of Media Experts Assessment

Aspects of Assessment	Score	Category
Language	4.4	Very good
Presentation	4.3	
Graphics	4.6	
Average	4.5	

The results of the feasibility assessment by the media expert lecturers are presented in Table 7. Based on Table 7, the result of the feasibility assessment by the media expert produces an average score of 4.5 in the very good category. Hence, the student worksheet is feasible to be used for learning. In line with a study by Nurfadhilah (2019), a product is valid if it is developed with adequate theory and all components of the learning product, namely the feasibility of content, language, presentation, and graphics, are consistently related.

The practicality of the student worksheet is obtained from the analysis of students' responses to the developed product. The results of the practicality analysis of student worksheet are presented Table 8.

Table 8. Results of the student worksheet Practicality Analysis

Assessment Aspect	Practicality Percentage (%)	Category
Content Eligibility	62	Practical
Presentation	62	
Language	66	
Graphics	62	
Coverage of Concept Understanding	64	
Average	64	

Based on Table 8, the average percentage obtained is 64%. This value is in the range of 60% - 79% so that the student worksheet is in the practical category. The analysis showed that the student worksheet is well received and can help students in the learning process. This is in line with a study by Parawansa (2018), which states that a good practicality test may be reached if the material delivered through the developed media is easy to understand and can motivate students to participate in science learning.

The effectiveness of student worksheets is seen from the score pretest and posttest. The analysis was carried out by conducting a different test to determine the difference between the pretest and posttest scores. Before the t-test, the data were analyzed with a prerequisite test to determine whether the data would be analyzed using parametric or nonparametric statistics. The result of the normality test shows the Asymp. Sig (2-tailed) of $0.014 < 0.025$ so that H_0 normality is rejected. This indicates that the hypothesis testing is carried out by nonparametric testing, namely testing of two related samples using Wilcoxon signed rank test. The result of the Wilcoxon signed rank test analysis is presented in Table 9.

Table 9. Results of the Wilcoxon Signed Rank Test Analysis

Test Statistics [a]	
	posttest-pretest
Z	-4.082 [b]
Asymp. Sig. (2-tailed)	< 0.001

Based on Table 9, the Asymp. Sig (2-tailed) is 0.001 where the result is less than 0.025, then Ho is rejected and Ha is accepted. This shows that there are significant differences in students' understanding of concepts after learning using student worksheets based on discovery learning.

Then, to find out the score and category of students' increasing understanding of the concept, an analysis is carried out using the normalized gain equation. The result of the n-Gain analysis is presented in Table 10.

Table 10. Result of the n-Gain Score of Concept Understanding

Concept understanding aspect	*n-Gain*	Category
Explain the material received	0.4	Medium
Give an example of the concept being studied	0.2	Low
Classify objects to form concepts	0.3	Medium
Provide an interpretation of the information obtained	0.3	Medium
Using the information obtained to solve problems	0.3	Medium
Average	0.4	Medium

Based on Table 10, the average value of n-Gain is obtained at 0.4 in the medium category. So, there is a significant increase in understanding of the concept. Based on these results, it can be concluded that the discovery learning -based worksheets can be effectively used to improve students' understanding of concepts. This is supported by a study conducted by Wahyuni *et al.* (2020), that the effectiveness of using REACT-based modules obtains an n-Gain of 0.66 in the medium category. This indicates that the module can be effectively used in learning. The finding of this study is also in line with a study by Nurjanah (2020), which learning using student worksheets based on discovery learning can improve students' conceptual understanding. This is shown by the average n-Gain result of 0.65 in the medium category and the effect size test. This shows an increase in understanding of concepts by 89%, which is influenced by learning using student worksheets based on discovery learning.

CONCLUSION

Student worksheet based on discovery learning has been produced that is feasible to improve students' conceptual understanding based on assessments by experts. The assessment by material experts produces an average score of 4.26 in the very good category, while the media expert assessment produces an average score of 4.5 in the very good category. The practicality of the student worksheet based on discovery learning is in the practical category in terms of student responses with a practicality percentage of 64%. The student worksheet based on discovery learning that has been developed is effective in learning based on the results of the Wilcoxon signed rank test analysis, which produces a significance level of 0.001. The score indicates that there are differences in students' understanding of concepts before and after learning using the worksheet. This is supported by the score of the n-Gain with a score of 0.4 in the medium category. Hence, it can be concluded that there is a significant increase in students' concept understanding after learning using the worksheet based on discovery learning. A further study can be conducted to try out the product with an offline setting so that students can carry out each stage in the worksheet optimally. Moreover, the worksheet can be tried out in several classes involving more students. Further study can also be done in adding an interview instrument to students to find out the students' responses.

REFERENCES

Arikunto, S. (2010). *Dasar-dasar Evaluasi Pendidikan*. Jakarta : Bumi Aksara.

Arsanty, V. N. (2017). Pengembangan Perangkat Pembelajaran Fisika Berbasis Model Pembelajaran STS dalam Peningkatan Penguasaan Materi dan Pencapaian Kreativitas Peserta Didik SMA. *Jurnal Pendidikan Fisika*, *6*(1), 23–32.

Chiapetta, E. L., & Koballa, T. R. (2010). *Science Instruction in the Middle and Secondary School: Developing Fundamental Knowledge and Skills* (7th ed.). New York : Pearson Education Inc.

Fitriani, U., Karyadi, B., & Ansori, I. (2017). Penerapan Model Discovery Learning Untuk Meningkatkan Pemahaman Konsep Biologi Siswa SMP. *Diklabio: Jurnal Pendidikan dan Pembelajaran Biologi*, *1*(1), 82–90.

Hake, R. R. (1998). Interactive-Engagement Versus Traditional Methods: A Six-Thousand-Student Survey Of Mechanics Test Data For Introductory Physics Courses. *American Journal of Physics*, *66* (1), 64–74.

Nahdi, S. D., Yonanda, D. A., & Agustin, N. F. (2018). Upaya Meningkatkan Pemahaman Konsep Siswa Melalui Penerapan Metode Demonstrasi pada Mata Pelajaran IPA. *Jurnal Cakrawala Pendas*, *4*(2), 9.

Nurfadhilah, U. (2019). Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbasis Discovery Learning Pada Materi Sel Kelas XI MIA MA Guppi Buntu Barana. *Skripsi*, tidak dipublikasikan. Universitas Islam Negeri Alauddin Makassar.

Nurjanah, S. (2020). Efektivitas Student worksheet Berbasis Discovery Learning Untuk Meningkatkan Keterampilan Kolaborasi Dan Penguasaan Konsep Peserta Didik. *Skripsi*, tidak dipublikasikan. Universitas Lampung.

Parawansa, D. A. (2018). *Respon Siswa Terhadap Lembar Kerja Peserta Didik (LKPD)*

Berbasis Keterampilan Proses Sains Pada Materi Virus Siswa Kelas X SMA Negeri 11 Makassar. 1–16. https://repository.unja.ac.id/2343/ .

Sugiyono. (2013). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Bandung: Alfabeta.

Sulthon. (2016). Pembelajaran IPA yang Efektif dan Menyenangkan Bagi Siswa Madrasah Ibtidaiyah (MI). *Jurnal Elementary*, *4*(1), 38–53.

Susilana, R. (2014). Pendekatan Saintifik Dalam Implementasi Kurikulum 2013 Berdasarkan Kajian Teori Psikologi Belajar. *EDUTECH*, *13*(2), 183–195.

Trianto. (2014). *Model Pembelajaran Terpadu Konsep Strategi, dan Implementasinya dalam Kurikulum Tingkat Satuan Pendidikan (KTSP)*. Jakarta: Bumi Aksara.

Wahyuni, S., Yati, M., & Fadila, A. (2020). Pengembangan Modul Matematika Berbasis REACT terhadap Kemampuan Komunikasi Matematis Peserta Didik. *Jambura Journal of Mathematics Education*, *1*(1), 1–12.

Wardani, D., & Nyoman, S. (2019) Developing Interactive Multimedia Model 4D for Teaching Natural Science Subject. *International Journal of Education and Research*, *7*(1), 63-72.

Wati, D., & Haryati, S. (2017). Pengembangan Lembar Kegiatan Peserta Didik (LKPD) Berbasis Discovery Learning Pada Pokok Bahasan Makromolekul. *Jurnal Keguruan dan Ilmu Pendidikan*, *4*(2), 1–15.

Widyoko, E. P. (2017). *Evaluasi Program Pembelajaran: Panduan Praktis bagi Pendidik dan Calon Pendidik*. Yogyakarta: Pustaka Pelajar.