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DEVELOPMENT OF DISCOVERY LEARNING-BASED LKPD TO DEVELOP SCIENCE PROCESS SKILLS ON PLANT CLASSIFICATION

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Abstract. This research is a development research (R&D) project that aims to determine the feasibility, practicality, and effectiveness of discovery learning-based Student worksheet products in developing science process skills for plant classification materials. The research design employs a one-group pre-test-post-test design. Data collection techniques use interview methods, observation, validation questionnaires for product assessment, and Pre-test and Post-test questions to measure learning outcomes. Data analysis was carried out descriptively, qualitatively and quantitatively. The results of the material expert validation obtained an average score of 3.89 with very good criteria, the results of the media expert validation obtained an average score of 3.87 with very good criteria, the results of the teacher assessment obtained an average score of 3.9 with very good criteria, the results of the student assessment showed a positive response in every aspect of the assessment. The results of the student worksheet effectiveness test, as determined by the Wilcoxon test, showed a significance value of 0.018 in the observation aspect and 0.000 in the classification, communication, and inference aspects. The N-gain of science process skills in the observation aspect falls into the medium category with a score of 0.5063, the classification aspect falls into the high category with a score of 0.7290, the communication aspect falls into the medium category with a score of 0.4362, and the inference aspect falls into the medium category with a score of 0.387. The results of the study indicate that the developed student worksheet is feasible, practical, and influential and effective in developing students' science process skills in the aspects of observation, classification, communication, and inference.
Keywords: Biology, Discovery learning, Plant classification, Science process skills, Student worksheet

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INTRODUCTION

Biology, as a science, is a combination of knowledge (product) and a method of discovery (process). Biology, as a process, is a method for solving problems through a series of stages known as the scientific method, which includes observing, formulating problems, presenting hypotheses, designing data collection methods, collecting data, analysing data, drawing conclusions, and communicating findings (Surachman, 2014). Prayitno (2011) stated that most biology learning in Indonesia is limited to the product aspect, resulting in content-based learning, where the success of the learning is measured by the number of concepts memorised by students. Content-based learning often fails to achieve the process and attitude aspects of science learning. According to Dewey (2004), knowledge should be gained through experience. In other words, to gain knowledge, students must be active by engaging in hands-on learning experiences (learning by doing). Students' lack of understanding of science process skills can be caused by several factors, including monotonous learning and a lack of student involvement in independently discovering concepts. Therefore, active student involvement is necessary to develop their science process skills (Putra & Suhartini, 2025).

An active learning process can be achieved through the use of teaching materials, which serve as guides for students in their learning. According to Oktavia (2019), teaching materials are essential for effective learning. One such material is the Student Worksheet. Developing a student worksheet, supported by an appropriate learning model, can engage students and facilitate their understanding of the material presented by the teacher. According to Salwan &

Rahmatan (2017), discovery learning-based student worksheet aims to increase direct student interaction during learning activities, enabling students to understand the material being studied by considering the principles of discovery learning, which include stimulation, problem identification, data collection, data processing, verification, and generalisation. The discovery learning model can encourage students to develop science process skills because students engage in learning through a series of procedures to identify problems, formulate research steps, provide explanations, predict outcomes, and draw conclusions based on data.

The classification of living things is one of the key concepts in biology with a very broad scope. The objects of study material for this material are often encountered in everyday life (Rasyid, 2023). Due to the breadth of the material, many students still struggle to understand the classification of living things. One factor that causes students to have difficulty in understanding the material is the teaching material that is not interesting. Therefore, interesting teaching materials are needed to increase students' curiosity. Discovery learning is characterised by the fact that the problems presented must be based on real phenomena in everyday life (Mahardita & Pratama, 2022). One material that meets the criteria for discovery learning is plant classification, as its characteristics are closely related to real phenomena that are integral to human daily life. Therefore, researchers in this study aim to develop a biology student worksheet based on discovery learning materials on plant classification to enhance students' science process skills.

METHOD

This development research adheres to the ADDIE development model, which includes analysis, design, development, implementation, and evaluation (Branch, 2009). However, this research is limited to the fourth stage, implementation, with limited product trials. The product trial design used was a one-group pre-test-post-test design. The reviewers included lecturers who were media experts, lecturers who were material experts, and biology teachers at SMA Negeri 1 Muntilan. The respondents included 29 students from SMA Negeri 1 Muntilan.

The data collection techniques and instruments used in this study were interviews, observations, questionnaires, and pre-test-post-test worksheets. Data analysis techniques included product feasibility and practicality analysis, as well as product effectiveness analysis. The feasibility and practicality analysis was conducted by calculating the average score for each item in the questionnaire.

Next, the results of the calculations are converted into qualitative data using the conversion rules proposed by Sudjana (2016), which are presented in Table 1.

Table 1. Conversion of quantitative data to qualitative data

Score Range	Category
$Mi + 1{,}5\ (SBi) < X \leq Mi + 3\ (SBi)$	Very Eligible
$Mi < X \leq Mi + 1{,}5\ (SBi)$	Eligible
$Mi - 1{,}5\ (SBi) < X \leq Mi$	Less Eligible
$Mi - 3\ (SBi) < X \leq Mi - 1{,}5\ (Sbi)$	Not Eligible

Description:

Mi (average score)	= 1/2 (maximum score + minimum score)
Sbi (standard deviation of ideal score)	= 1/6 (maximum score – minimum score)
X	= score obtained

The analysis of the product's effectiveness in improving science process skills was conducted through a pre-test and post-test. The pre-test and post-test data were then processed using the SPSS statistical testing application through several tests, namely the normality test, paired sample t-test, Wilcoxon test, and n-gain test. The N-gain assessment criteria are as follows (Hake, 1999) (Table 2).

Table 2. N-gain value criteria

Gain Normality Value	Criteria
$0{,}70 \leq n \leq 1{,}00$	High
$0{,}30 \leq n \leq 0{,}70$	Medium
$0{,}00 \leq n \leq 0{,}30$	Low

Analysis of the science process skills sheet was carried out by calculating the results of the observation sheet using the following equation:

$$\text{Value} = \frac{Obtained\ score}{Total\ Score\ Amount} x100\%$$

The results of these calculations are then made into quantitative data to determine the classification categories of students' science process skills with the criteria in Table 3 (Widoyoko, 2009).

Table 3. Student science process skills categories

Percentage	Category
86% - 100%	Very high
76% - 85%	High
66% - 75%	Moderate
56% - 65%	Low
≤ 55%	Very low

RESULTS AND DISCUSSION

Results

Analysis Stage

Based on observations and interviews with biology teachers at Muntilan 1 State Senior High School, it was discovered that biology learning activities were largely conducted in the classroom, utilising various learning methods such as group discussions, lectures, presentations, and Q&A sessions. The interviews revealed that teachers had not yet implemented discovery learning methods, particularly in the context of plant classification. One of the learning tools used by teachers was student worksheets, which contained questions and problems for students to solve through group discussions. However, these student worksheets were not designed to encourage students to explore their surroundings. This resulted in suboptimal learning outcomes in developing science process skills.

Observations of classroom learning revealed that the level of active student participation within groups was still uneven. During group discussions, there was a tendency for only a few students to participate in the tasks within the student worksheet actively. Given these conditions, implementing discovery learning-based student worksheets could be an appropriate alternative solution. Discovery learning encourages students to discover concepts independently through a series of structured activities, facilitates the development of science process skills, and accommodates diverse student characteristics.

Design Stage

At this stage, the product to be developed is designed, and this design serves as a reference for creating the media. This stage involves several steps, including material review, designing student worksheets, and developing assessment instruments. In this study, the researcher used the Canva design application to create the student worksheet product. The student worksheet product framework design consists of a cover, author identity, table of contents, learning outcomes and objectives, student worksheet usage instructions, materials, student activities, and a bibliography.

Development Stage

The development stage is the assessment stage for the product that has been developed. Subject matter experts and media experts conduct the assessment. The assessment is conducted to evaluate the product that has been developed, ensuring the resulting product is improved and suitable for use as a teaching material. The stages in product validation are:

Subject Matter Expert Validation

The expert validation test was conducted by expert lecturers who had mastered the material on plant classification, as evidenced by their completion of a questionnaire. The aspects assessed included content components, presentation aspects, and linguistic aspects. The results of the expert assessment are presented in Table 4.

Table 4. Results of validation by material experts

Aspect	Score	Category
Content Components	4	Very good
Presentation Aspects	4	Very good
Language Aspects	3.67	Very good
Average	3.89	Very good

Media Expert Validation

Aspects validated by media experts include design/graphics, presentation, language, and usage. The results of the media expert validation are presented in Table 5.

Table 5. Media expert validation results

Aspect	Score	Category
Design/Graphics	4	Very good
Presentation	4	Very good
Language	3.80	Very good
Usage	3.67	Very good
Average	3.87	Very good

Practitioner (Teacher) Assessment

The practicality test of the student worksheet product was conducted by high school biology teachers, who serve as learning practitioners. Aspects assessed by the practitioners included material, presentation, language, and usability. The results of the teacher's feasibility assessment are presented in Table 6.

Table 6. Teacher assessment results

Aspect	Score	Category
Material Aspect	3.8	Very good
Presentation Aspect	3.9	Very good
Language Aspect	3.8	Very good
Usage Aspect	4	Very good
Average	3.9	Very good

Student Assessment

A student product assessment was conducted using a questionnaire with a 1-4 Likert scale. The questionnaire was completed by all 29 students who participated in the discovery learning-based student worksheet learning activities. The results of the student worksheet assessment are presented in Table 7.

Implementation Stage

After undergoing the development stage, the product was implemented to assess the effectiveness of discovery learning-based worksheets in developing science process skills. Product implementation in this study was conducted through a limited trial in one class, Grade 10/Phase E, at the school. Pre-test and post-test data obtained from the trial were then analysed using SPSS through several tests to determine the product's effectiveness in developing science process skills. The science process skills aspects assessed in this study included four aspects aligned with the syntax of the discovery learning approach. These four aspects of science process skills are observation, classification, communication, and inference. The statistical test data are described as follows.

Table 7. Results of the student worksheet assessment by students

No	Indikator Penilaian	Penilaian			
		4	3	2	1
1	I can easily understand the material in the worksheet.	24.1 %	75.9%		
2	The activities in the worksheet are presented in a structured manner to avoid confusion.	34.5%	65.5%		
3	I find the cover design of the worksheet attractive.	58.6%	41.4%		
4	The layout of the worksheet is consistent, making it easy for me to understand.	58.6%	41.4%		
5	The images, illustrations, and photos presented are attractive and clear.	69.0%	31.0%		
6	The content of the worksheet aligns with the table of contents.	62.0%	38.0%		
7	The language used in the worksheet is easy to understand.	48.3%	51.7%		
8	The language used in the worksheet aligns with the General Guidelines for Indonesian Spelling (PUEBI).	65.5%	34.5%		
9	The instructions for using the worksheet are easy for me to understand.	42.4%	58.6%		
10	The work procedures in the worksheet make it easy for me to understand what I need to do.	38.0%	62.0%		
11	The activities in the worksheet practice science process skills.	48.3%	51.7%		
12	This worksheet meets my learning needs.	44.8%	55.2%		
13	Using this worksheet has helped me better understand the material on plant classification.	48.3%	51.7%		

Normality Test Result

The normality test was conducted as a prerequisite for a series of tests evaluating the effectiveness of the developed student worksheet products. The results of the normality test for the pre-test and post-test scores for each aspect of science process skills are presented in Table 8.

Table 8. Results of the normality test for each aspect of science process skills

Aspect	Shapiro-Wilk		
	Statistic	df	Sig.
Observation Pre-test	0.907	29	0.014
Observation Post-test	0.778	29	0
Classification Pre-test	0.785	29	0
Classification Post-test	0.882	29	0.004
Communication Pre-test	0.849	29	0.001
Communication Post-test	0.889	29	0.005
Inference Pre-test	0.927	29	0.047
Inference Post-test	0.884	29	0.004

Based on Table 8, it is evident that the pre-test and post-test results for each aspect of the KPS did not meet the assumption of normality ($p < 0.05$). Therefore, a non-parametric test, namely the Wilcoxon test, was used to determine whether there was an increase in the pre-test and post-test scores for each aspect of science process skills.

Uji Wilcoxon

The Wilcoxon test is a non-parametric statistical analysis technique used to determine the significance of differences between two groups of paired data that are not normally distributed. This test is an alternative to the paired sample t-test and is used when the data do not meet the assumption of normality. The results of the Wilcoxon test for science process skills are presented in Table 9.

Table 9. Wilcoxon test results

	Post-test **Observation -** ***Pre-test*** **Observation**	***Post-test*** **Classification -** ***Pre-test*** **Classification**	***Post-test*** **Communication -** ***Pre-test*** **Communication**	**Post-test Inference -** ***Pre-test*** **Inference**
Z	-2.356[b]	-4.726[b]	-3.756[b]	-4.064[b]
Asymp. Sig. (2-tailed)	.018	.000	.000	.000

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N-gain Test Results

The N-gain test was conducted to determine the quality of improvement in each aspect of students' science process skills before and after treatment, specifically learning through discovery learning worksheets. The results of the N-gain test are presented in Table 10.

Table 10. N-gain test results for each science process skill aspect

Aspects	Minimum	Maximum	Mean	*Std. Deviation*
Observation	-2.00	1.00	5063	.71450
Classification	.20	1.00	7290	.23676
Communication	-.86	1.00	4362	.44037
Inference	-.76	1.00	3877	.36098

Science Process Skills Observation Sheet Analysis

During the learning activities using discovery learning-based worksheets on plant classification, researchers also conducted observations to analyse students' science process skills. The results of the students' science process skill scores, based on observations, are shown in Table 11.

Table 11. Average KPS scores of students based on observation sheets

No	Aspects	Percentage	Category
1.	Observation	87%	Very good
2.	Classification	78%	Good
3.	Communication	83%	Good
4.	Inference	78%	Good
	Mean	81,5%	Baik

Discussion

The development of the Student Worksheet product begins with the analysis phase. This phase aims to identify the need for developing a discovery learning-based student worksheet to develop students' science process skills. The analysis phase involves gathering information related to the problems and needs in product development. The data obtained at this stage is descriptive data generated through interviews with high school biology teachers. The interviews revealed that teachers have not yet developed a discovery learning student worksheet in biology instruction. Observations indicate that the student worksheet used only contains a collection of questions and problems to be answered by students, without any systematic guidance to help them conduct discovery activities. The student worksheet also lacks activities that encourage the development of students' science process skills. The student worksheet used emphasises problem-solving rather than independent concept discovery by

students. Furthermore, learning activities are dominated by problem-solving rather than activities that guide students in independently acquiring concepts.

The next stage after the analysis phase is the design phase. This stage involves designing the student worksheet product and developing validation instruments in collaboration with subject matter experts, media experts, teacher response questionnaires, and student response questionnaires. After the design stage, the development stage continues. During the development stage, the student worksheet is assessed to determine its feasibility. The feasibility assessment is carried out by validating the developed student worksheet by lecturers who are subject matter experts and media experts. According to Burgawanti et al. (2023), a good student worksheet meets the criteria for didactic requirements, construction requirements, and technical requirements, has an attractive appearance, and aligns with basic competencies, competency achievement indicators, and the learning objectives to be achieved.

Validation by material experts was conducted by lecturers specialising in material and encompassing several aspects: content suitability, presentation, and language. Based on the analysis of the material expert assessment results, using a Likert scale of 1-4, the content component received an average score of 4. The validation results from the material experts, as shown in Table 4, indicate that the presentation aspect received an average score of 4. The language aspect received an average score of 3.67. Overall, the validation results, as assessed by the material experts, indicate that the developed worksheets meet the criteria of 'very good' or 'very suitable' based on the assessment of content, presentation, and language suitability.

The discovery learning-based student worksheets were also assessed by lecturers specialising in media across four aspects: design, presentation, language, and usability, as presented in Table 5. The media expert's assessment of the design/graphics and presentation aspects received a score of 4, indicating very good. The language aspect received a score of 3.8, also indicating very good, and the usability aspect received a score of 3.67, also indicating very good. Overall, the validation results, as assessed by media experts, indicated that the developed worksheet met the criteria of "very good"/"very suitable" for use, based on assessments of design, presentation, language, and usability.

The product's practicality was evaluated through assessments conducted by biology teachers, who served as learning practitioners. The results of the biology teacher assessments indicated that the developed worksheet was generally very suitable for use as a learning tool. This result is presented in Table 6, where the material aspect received a score of 3.8, the presentation aspect received a score of 3.9, the language aspect received a score of 3.8, and the usability aspect received a score of 4. Therefore, the average product feasibility score was 3.9, which falls into the "very good" category.

Furthermore, the product's practicality was also assessed through student assessments. The assessment results showed that the discovery learning-based worksheet received a positive response from students, with responses of "strongly agree" and "agree" for each aspect. This result indicates that the developed worksheet met the criteria of "good" in terms of material, presentation, design, language, and implementation in learning activities.

The effectiveness test of the student worksheet on science process skills was carried out using a normality test as a prerequisite, followed by a paired sample t-test to determine whether there was a significant difference between the Pre-test and Post-test scores, and an N-gain test to determine the improvement in students' science process skills. The results of the normality test showed that the data were not normally distributed. Because the data did not meet the normality assumption, an alternative test, the Wilcoxon test, was then carried out to determine whether there was a change in student learning outcomes after learning using a student worksheet based on discovery learning.

Based on the Wilcoxon test, all aspects of science process skills measured had a significance value (p-value) <0.05. This result indicates a significant difference between the

pre-test scores before learning with discovery learning-based worksheets and the post-test scores after learning with discovery learning-based worksheets. These results indicate that learning using discovery learning-based worksheets is effective in developing students' science process skills in observation, classification, communication, and inference on plant classification.

After the worksheet product was identified as having an impact on the development of students' science process skills, an N-gain test was conducted to measure the product's effectiveness. The N-gain test was conducted on each aspect of science process skills measured: observation, classification, communication, and inference. The N-gain score was calculated by comparing the pre-test and post-test scores to determine the effectiveness of the discovery learning-based worksheets in developing science process skills.

A significant improvement in learning outcomes was demonstrated in the classification aspect, with a score of 0.72904, which is categorised as high. A high N-gain score indicates that students have gained a better understanding and can apply the concepts learned effectively. This means that the application of the discovery learning worksheet is highly effective in improving science process skills, particularly in the classification aspect. Meanwhile, the observation, communication, and inference science process skills (SPS) aspect falls into the moderate category, with an N-gain score of 0.5063 for observation, 0.4362 for communication, and 0.3877 for inference. The moderate category indicates that science process skills have improved quite well, but there is still room for improvement to enable students to gain a deeper understanding. The discovery learning model is effective in developing the SPS of observation, communication, and inference, but not as strong as the high category.

Based on observations during the learning activities, students' observation scores fall into the very good category, with an average score of 87%. This result indicates that students can observe objects in detail and systematically. In the classification, the average score obtained by students was 78%, which falls in the good category. This result indicates that students can accurately group objects based on observed characteristics (Atiqoh & Suhandoyo, 2022). The average student score for the communication aspect was 83%, which is considered a good result. Students were able to convey their observations clearly and systematically. Meanwhile, the average student score for the inference aspect was 78%, which is considered a good result. This result suggests that students can draw accurate conclusions based on the data and concepts they acquire during the learning activities. Overall, the observed students' science process skills were considered good (Mahardita & Pratama, 2022).

The use of the discovery learning model in biology education to develop students' science process skills aligns with research findings (Bahtiar & Dukomalamo, 2019) that indicate the discovery learning model can significantly improve students' basic science process skills compared to conventional learning models in biology education. Discovery learning enables students to encounter various situations, questions, or tasks that encourage them to discover concepts or learning materials independently (Levy et al., 2018; Wilke & Straits, 2001). Through discovery learning, students are fully engaged in using all their abilities to systematically, critically, and logically discover and investigate, enabling them to develop their skills, attitudes, and knowledge independently.

According to Nasir et al. (2023), science process skills are crucial in today's modern learning era, given the dynamic development of science and technology, as well as the importance of developing concepts that shape students' attitudes and values. These skills include observing, formulating hypotheses, planning and conducting experiments, interpreting data, classifying results, and communicating findings (Setiawan & Sugiyanto, 2020). These process skills can be developed through the discovery learning model, which requires students to solve problems by posing questions and sharing opinions (Khasinah, 2021).

In the independent curriculum, biology learning outcomes consist of elements of material understanding and process skills. However, in practice, biology learning often prioritises scientific product outcomes over the process. This result can occur because the assessment system focuses on the final product and ignores the scientific process aspect (Ungirwalu et al., 2025). Education, however, is a lifelong process and does not end with formal schooling. Therefore, the process skills acquired in formal education are crucial for preparing students to face future challenges (Aisah & Agustini, 2024).

The discovery learning-based biology worksheets developed are effective in improving students' science process skills. These results align with research (Roheni et al., 2020) that found that the application of the discovery learning model can develop students' science process skills. Learning using the discovery learning model facilitates students' science process skills through direct involvement and experience.

In this study, the science process skill aspect that experienced the highest improvement was classification. This result occurs because in previous learning, students rarely processed data from their own observations. Students are not accustomed to building conceptual understanding through a series of scientific discovery activities, as teacher explanations often dominate learning, and the worksheets used generally contain questions that can be solved without requiring a series of scientific activities. With the discovery learning model, students are encouraged to be directly involved in the exploration process, enabling them to understand learning concepts more deeply (Ungirwalu et al., 2025). Thus, discovery learning-based worksheets can help develop students' science process skills.

CONCLUSION

Based on the development research that has been conducted, it can be concluded that the discovery learning-based student worksheet for developing students' science process skills on plant classification material is feasible, practical, and proven to be influential and effective in developing students' science process skills in the aspects of observation, classification, communication, and inference. The results of this study are expected to be an alternative teaching material that can be used by teachers in the classroom.

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