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DEVELOPMENT OF STUDENT WORKSHEET ON PROTOZOA MATERIAL FOR MASTERY OF CONCEPTS AND CRITICAL THINKING SKILLS AT SEKOLAH MENENGAH PERTAMA NEGERI 16 MEDAN

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Abstract

The development of this student worksheet was driven by the need for guided discovery-based worksheets in protozoa practicum activities to enhance students' concept mastery and critical thinking skills. This study aimed to determine the feasibility, practicality, and effectiveness of the developed worksheet. The research employed the ADDIE model and involved data collection through interviews and questionnaires, followed by both quantitative and qualitative descriptive analysis. The subjects of the study were students and teachers of Sekolah Menengah Pertama Negeri 16 Medan. The results showed that the feasibility test of student work sheet material obtained 87% and media 95% after product revision. For the practicality test, the teacher's response was 97% and students 94%. The effectiveness test shows that N-Gain on the concept mastery variable is 0.7563 (75.63%) and on critical thinking skills is 0.7705 (77.05%) and both are in the high and effective categories. This value shows that student work sheet not only helps understanding the material but also improves concept mastery and critical thinking skills. It can be concluded that the student work sheet developed is very feasible, practical and effective to use in learning.

Keywords: ***Student work sheet, Concept Mastery, Critical Thinking Skills, Protozoa.***

1. INTRODUCTION

This is about protozoa which includes various types of unicellular organisms, have different means of locomotion, shapes and different types of protozoa in their habitats. Protozoa usually live in habitats, one of which is in pond water, straw and rivers. Understanding protozoa not only provides insight into biology, but also into the interactions of life in ecosystems. However, many students have difficulty understanding this material because of its abstract nature and lack of direct experience. This can be seen from the value of the protozoa material obtained below learning objectives achievement criteria, indicating that students do not master the protozoa material with mastery of its concepts and there is no emergence of critical thinking actions from students.

This protozoa material will be more interesting to students if presented in the right media. According to Dhori (2021) that one of the determining factors for the success or failure of learning is the selection of the right learning media. According to Suci (2022), the difficulty in understanding this protozoa material is due to the lack of learning media such as student work sheet which helps students to understand the material and train their critical thinking skills better. Based on the description above, research that uses student worksheets in the learning process in practical activities is important to be carried out using the guided discovery method as an activity to hone students' mastery of concepts and critical thinking.

2. LITERATURE REVIEW

Wulandari (2013) stated that the role of student work sheet is very large in the learning process because it can increase student activity in learning and its use in learning can help teachers to direct their students to find concepts through their own activities. In addition, student work sheet can also develop process skills, increase student activity and can optimize learning outcomes. The objectives of compiling student work sheet according to Prastowo (2012) include the following: (1) presenting teaching materials that make it easier for students to interact with the material given, (2) presenting tasks that increase student mastery of the material given, (3) training student learning independence (4) making it easier for educators to give assignments to students. According to Faiz (2012), critical

thinking is a mental process to analyze or evaluate with observation, experience, common sense by receiving information or knowledge that they have. Concept mastery is the ability of students to understand learning materials given by teachers. Concept mastery is a student's understanding or ability of abstractions that have one class of objects, events, and activities that have the same symbols (Nugraha, 2018). This research employed the Analysis, Design, Development, Implementation, Evaluation (ADDIE) model and involved data collection through interviews and questionnaires, followed by both quantitative and qualitative descriptive analysis. The ADDIE model design consists of five steps or phases of development including analysis, design, development, implementation and evaluations. The ADDIE model design was developed by Dick & Carry in 1996 to develop learning products (Cahyadi, 2019).

The learning method in the practicum used guided discovery. Guided discovery is one of the learning methods used by teachers in the student-centered teaching and learning process, where in this process students are actively involved in finding their own concepts and principles by using their own mental processes. In this method, it does not mean that something discovered by students is completely new, because the discovery referred to here is not a real discovery, but what is discovered by students is something that has been discovered or known before by others. It's just that the knowledge is indeed new knowledge for the students themselves.

The developed student work sheet studies protozoa in its practicum. Generally, protozoa can only be seen under a microscope. The morphology of protozoa varies, their physiology and metabolism are adjusted to their needs. The characteristics of protozoa are as follows, a) Generally cannot make their own food (heterotrophs), b). Protozoa have a means of movement, namely pseudopods, vibrating hairs (cillia) or whip hairs (flagellum), c) Free-living, saprophytic or parasitic, d) Single-celled organisms, e) Eukaryotic or have a nuclear membrane/true nucleus. f. Live solitary (alone) or in colonies (groups), g) Can form cysts to survive. cysts, are a form of protozoan cells that are dehydrated and have thick walls similar to endospores that occur in bacteria, h) Protozoa are able to survive in dry or wet environments, i) Protozoa do not have cell walls, j) Protozoa are microscopic organisms that are prokaryotes

The role of protozoa in human life in some protozoa can provide benefits to human life and also some protozoa have disadvantages. The benefits of protozoa include: a) as a basic material for making abrasives. Radiolarian shell deposits at the bottom of the water will form radiolarian soil, the soil contains grit and can be used as abrasives, 2) As an indicator of petroleum. Globigerina body frame deposits at the bottom of the water will form globigerina soil. These deposits are commonly used as an indication of the presence of petroleum, 3) Helping the process of rotting food waste. Helping the process of rotting food waste in humans. For example, Entamoeba coli.

3. METHOD

3.1 Research Design

This study utilized a Research and Development (R&D) approach (Budiyono, 2017) to create a valid, practical, and effective Student Worksheet for teaching protozoa usage ADDIE model. This systematic framework ensured iterative refinement through expert validation and user feedback at each stage, aligning with Indonesia's Merdeka Curriculum requirements. The research was carried out at SMP Negeri 16 Medan during the early part of 2025.

3.2 Participants

The research involved 60 students from grade VII, divided into two equal groups: an experimental group, which received instruction using the develop student worksheet, and a control group, which followed conventional learning methods without the use of student work sheet. A total sampling technique was employed, where all students from selected classes were included in the study. This approach allowed for a comprehensive evaluation of the effectiveness of the developed media under actual classroom conditions.

3.3 Research Procedure and Design

This model promotes critical thinking by aligning learning resources with students' needs and characteristics. Rusmayana (2020) highlights the model's rational and comprehensive nature, suitable for developing various educational products, including learning models, strategies, methods, media, and materials, with continuous evaluation and revision to ensure product validity.

3.3.1 Analysis Phase

The analysis phase examines learning process components, including curriculum, student characteristics, and needs assessment. Curriculum analysis ensures LKPD alignment with the Merdeka Curriculum at SMPN 16

Medan, focusing on Protozoa and its role as a learning objective. Student characteristics analysis evaluates knowledge, skills, and attitudes to foster creative and critical thinking, aligning with the Pancasila Student Profile attributes: faith, global diversity, collaboration, independence, and critical reasoning (Manasikana, 2022). Needs assessment indicates that 85% of teachers and 96% of students support work sheet use to enhance conceptual mastery and critical thinking, as existing practicum methods are inadequate.

3.3.2 Design Phase

The design phase involves creating the work sheet based on analysis outcomes. This includes selecting materials aligned with learning outcomes, defining indicators, and designing content, structure, colors, and visuals to stimulate critical thinking. References for questions and content are compiled, and validation instruments, such as work sheet and teacher evaluation questionnaires, are developed and validated. Assessment criteria for the work sheet design include clarity of instructions, alignment with learning objectives, visual appeal, and language suitability for seventh-grade students.

3.3.3 Development Phase

The development phase realizes the designed work sheet, followed by validation by experts in content, media, language, and teaching practice to ensure validity (Sugiono, 2018). Validators assess the LKPD using predefined instruments, providing feedback to minimize errors. Assessment criteria include didactic aspects (learning process support, concept mastery, and critical thinking development), construction (language accuracy and student compatibility), and technical aspects (font, image, color suitability, and layout appeal). A limited trial with five eighth-grade students, familiar with Protozoa, evaluates usability, followed by teacher evaluations from two educators to refine the work sheet.

3.3.4 Implementation Phase

The validated work sheet is duplicated for 60 seventh-grade students at SMPN 16 Medan and tested to assess feasibility and effectiveness in teaching Protozoa. Pre- and post-tests measure improvements in conceptual mastery and critical thinking, while student response questionnaires evaluate practicality. Assessment criteria include work sheet usability, material accuracy, and effectiveness in enhancing learning outcomes, as measured by test scores and student feedback.

3.3.5 Evaluation Phase

The evaluation phase analyzes validator feedback, student responses, and test results to determine the work sheet's validity, practicality, and effectiveness. Revisions are based on expert critiques or invalid assessments, with iterative evaluations ensuring a high-quality product. Assessment criteria include validity (alignment with curriculum and learning goals), practicality (ease of use and student engagement), and effectiveness (improved learning outcomes), as evidenced by positive student responses and test score improvements.

3.4 Instruments and Data Collection Techniques

Data collection utilizes interviews, questionnaires, observations, and tests to ensure accuracy and relevance (Sugiyono, 2018; Sukendra, 2020). Structured interviews with teachers highlight the limitations of teacher-centered practicum methods, emphasizing work sheet's role in fostering critical thinking and conceptual mastery. Questionnaires include validation sheets for media (didactic, construction, and technical aspects) and content (material accuracy, linguistic clarity, and graphic presentation), as well as student and teacher response questionnaires. Tests comprise 15 multiple-choice questions for conceptual mastery and 15 for critical thinking, validated using Ennis's (1985) indicators providing explanations, developing basic skills, drawing conclusions, offering further explanations, and formulating strategies. Assessment criteria for tests include question validity, reliability, and difficulty level balance.

3.5 Data Analysis Techniques

Data analysis combines qualitative and quantitative descriptive methods. Qualitative analysis processes validator feedback and observations to guide work sheet revisions, while quantitative analysis evaluates validity, practicality, and effectiveness using Likert scales and percentage calculations. Validity is assessed through media and content validation sheets with scores categorized from not feasible (1) to very feasible (4) and converted to Likert scale. Criteria for validity as shown in table 3.1.

Table 3.1 Data validity criteria (Akbar, 2013)

Scale	Criteria	Description
4	81-100%	Very Valid
3	61-80%	Valid
2	41-60%	Moderately Valid
1	21-40%	Not Valid
1	0–20%	very invalid

Reliability is tested using Cronbach's Alpha as shown in table 3.2.

Table 3.2 Reliability criteria (Purwanto, 2021)

No	Koefisien Validitas	Kriteria Korelasi
1	0.90 - 1.00	Very High
2	0.70 - 0.90	High
3	0.40 - 0.70	Moderate
4	0.20 – 0.40	Low
5	0.00 – 0.20	Almost No Correlation

Test difficulty levels are calculated to ensure a balanced distribution using Arikunto's (2013) formula as shown in table 3.3

Table 3.3 Interpretation of difficulty level

No	Difficulty Level Range	Category
1	0.00 – 0.31	Difficult
2	0.31 - 0.71	Moderate
3	0.71 – 1.00	Easy

An Independent Sample T-Test compares control and experimental group post-test scores, and N-Gain analysis quantifies learning improvements, with criteria as shown in table 3.4

Table 3.4 N-Gain Score

N-Gain Score	Category
$g > 0,7$	High
$0,3 < g < 0,7$	Moderate
$G \leq 0,3$	Low

4. RESULTS AND DISCUSSION

4.1 Description of Product Development

The research was carried out to develop a guided discovery-based student worksheet aimed at improving students' mastery of protozoan concepts and critical thinking skills in science education. The development process employed the ADDIE model, which is widely recognized for its systematic approach in instructional design. During the initial analysis phase, both students and teachers at SMP Negeri 16 Medan were surveyed using questionnaires. Results showed that 92% of students had difficulties understanding protozoa through traditional methods, particularly due to the abstract nature of the content. Moreover, 84% of students reported needing structured guidance to conduct experiments and draw conclusions. Simultaneously, teachers (100%) expressed a lack of adequate media support and highlighted the necessity of guided worksheets to facilitate the understanding of microscopic organisms.

These findings underscore the importance of developing an instructional product that bridges the gap between abstract biological content and practical student comprehension. By focusing on guided discovery, the student worksheet aimed to encourage students to actively engage in observation, analysis, hypothesis formation, and conclusion drawing during laboratory-based activities.

4.2 Product Design and Specification

In the design phase, the student worksheet was developed based on learning objectives outlined in Indonesia's Kurikulum Merdeka for science in junior high schools. The learning goals were aligned with competencies related to identifying characteristics, classifying types, and understanding the ecological role of protozoa. To accommodate diverse learning needs, the student worksheet was structured into various sections including a cover, table of contents, concept map, student and teacher instructions, and detailed practical activities. Each practical activity was organized with clear titles, objectives, materials, procedural steps, observation tables, and follow-up reflection questions to foster critical analysis. Additionally, the student worksheet incorporated assessment tasks such as multiple-choice questions, matching exercises, and crossword puzzles designed to maintain student engagement and cater to different cognitive levels. The inclusion of varied question formats was intended to reduce fatigue and enhance motivation. Importantly, the design process also considered visual appeal, layout clarity, and language appropriateness to ensure usability by both students and educators.

4.3 Product Validation

Expert validation is essential to ensure the quality and credibility of an instructional product. In this study, validation was conducted by two subject matter experts (biology lecturers) and two media experts. The material experts assessed the student worksheet based on content accuracy, relevance, and alignment with learning objectives. The media experts evaluated visual design, readability, layout, and instructional clarity. The material experts awarded an average score of 87%, which falls under the very valid category. Minor revisions were suggested, such as correcting Latin nomenclature, enhancing images (magnifying the structure of Paramecium), and improving the layout of the concept map. Meanwhile, the media experts provided a higher validation score of 95%, indicating the product's strong visual and pedagogical quality. Their suggestions focused on improving the color scheme, consistency of design across activities, and inclusion of student identity on the cover page. All feedback was incorporated, and the student worksheet was revised before implementation.

4.4 Product Implementation and Trial

Implementation of the student worksheet was carried out through three stages of trials: small-scale (3 students), medium-scale (9 students), and large-scale (21 students). Each group included students with varying academic achievement levels (high, moderate, and low) to assess the adaptability and comprehensibility of the student worksheet. In the small-scale trial, the student worksheet scored an average of 80%, categorized as good. The medium-scale trial yielded a score of 88% (very good), and the large-scale trial achieved 97% (very good). These consistent improvements indicated that the student worksheet became more effective and acceptable after each revision. Feedback from students during the trials confirmed that the activities were easy to follow, interesting, and enhanced their understanding of protozoa. This iterative trial process ensured that the final product was well-optimized for classroom implementation.

4.5 Learning Outcome Analysis

The study employed a quasi-experimental design, comparing an experimental class (using the student worksheet) with a control class (using traditional methods). Pre-test and post-test were administered to both groups to assess the impact of student worksheet on conceptual understanding and critical thinking. Results showed a notable increase in scores for the experimental class. The mean post-test scores for conceptual understanding and critical thinking were 81.80 and 83.43, respectively, compared to the control group's 73.40 and 70.97. These findings suggest that students who used the student worksheet performed better in both domains.

Further, a paired sample t-test was conducted, revealing a significance value of 0.000 ($p < 0.05$), indicating a statistically significant difference between the experimental and control groups. This confirms that the use of student worksheet had a positive and measurable effect on student learning outcomes.

4.6 Effectiveness Based on N-Gain

To measure the effectiveness of the instructional intervention quantitatively, the normalized gain (N-Gain) was calculated for both conceptual understanding and critical thinking. The N-Gain score for conceptual understanding was 0.7563 (75.63%) and for critical thinking 0.7705 (77.05%), both of which fall into the high effectiveness category according to standard interpretation criteria (Hake, 1998). These results validate the pedagogical value of the student worksheet as a learning tool that can substantially increase students' learning gains

over time. The high gain also reflects that the product was successful not only in conveying scientific knowledge but also in developing students' reasoning and analytical abilities.

4.7 Practicality Evaluation

In addition to validity and effectiveness, practicality is an important aspect of instructional design. The practicality of the student worksheet was evaluated based on the responses of two science teachers and 30 students from the experimental class. The teacher response yielded an average score of 97%, while the student response averaged 94%, both categorized as very practical. Teachers noted that the student worksheet was easy to implement, facilitated classroom management during laboratory sessions, and aligned well with the intended learning outcomes. Students reported that the student worksheet was visually appealing, easy to understand, and helpful in guiding them through complex experimental procedures. These responses indicate that the work sheet not only theoretically sound but also feasible and user-friendly for day-to-day classroom use.

4.8 Final Product Student Worksheet

The final product developed in this study is a Guided Discovery-based Student Worksheet specifically designed to facilitate practical learning on the topic of protozoa for Grade VII students. This work sheet serves as a comprehensive instructional tool that guides students through the process of scientific inquiry by integrating observation, experimentation, data analysis, and critical reflection. Several sections of the product were enhanced, as demonstrated in the following examples.

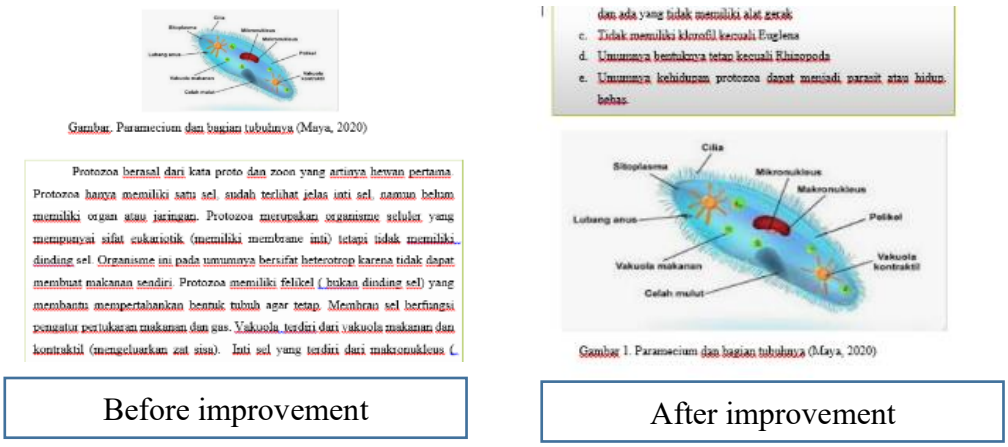

Figure 4.1 Worksheet student content improvement

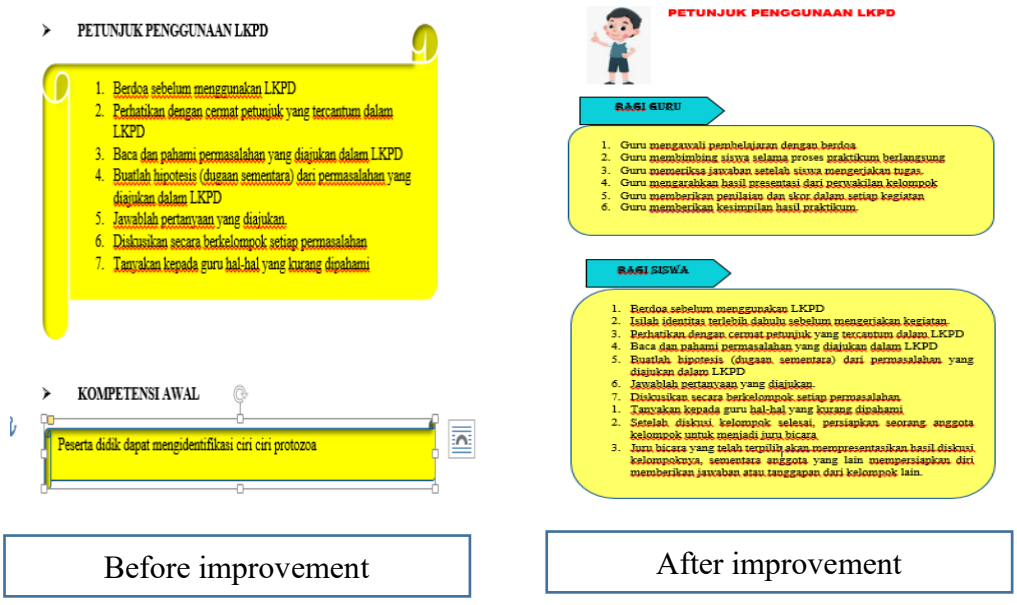

Figure 4.2 Revision of worksheet student usage instructions

This shows that student work sheet is not only a medium for practicing questions, but also functions as a tool for developing high-order thinking skills (HOTS), because it encourages students to actively analyze, evaluate, and conclude information.

4. CONCLUSION AND SUGGESTIONS

This study generally aims to develop and test the feasibility, practicality, and effectiveness of student worksheets as a learning medium. However, at this stage, quantitative analysis is focused on the effectiveness aspect, because the data for the feasibility and practicality tests are not yet empirically available.

1. The level of expert feasibility of student work sheet on protozoa material to improve concept mastery and critical thinking is categorized as very feasible.
2. The level of media expert feasibility of student work sheet on protozoa material to improve concept mastery and critical thinking is categorized as very feasible.
3. The results of student responses to student work sheet on protozoa material for grade VII junior high school are categorized as very practical
4. The effectiveness of the student work sheet used is stated to be effective with the N-Gain value of the conceptual understanding aspect of 76% and critical thinking skills of 77%. Thus, student work sheet is proven to be able to facilitate learning that encourages students to better understand the material and develop high-level thinking skills significantly.

Suggestions

1. For teachers, it is recommended to integrate student work sheet in the learning process as part of an active learning strategy. Well-designed student work sheet can be an effective tool to improve students' conceptual understanding and critical thinking skills.
2. for student work sheet developers, it is important to continue to improve the content, structure, and design of student work sheet to make it more attractive, easy to use, and in accordance with the characteristics of students and curriculum demands.
3. For Further researchers, it is recommended to continue this research by including empirical feasibility and practicality tests, as well as applying student work sheet to various subjects or levels of education to obtain broader generalizations.

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