Jurnal Pembelajaran Dan Biologi Nukleus p-ISSN: 2442-9481
Vol 10 (2): 664-681, July 2024 e-ISSN: 2685-7332

Development of Student Worksheet based on Discovery Learning Reproductive System Materials in Improving Higher Order Thinking Skills of Senior High School level-Madrasah Aliyah Students

Yuli Erpianna Harahap(*), Ummi Nur Affini Dwi Jayanti

Tadris Biologi, Fakultas Ilmu Tarbiyah dan Keguruan, Universitas Islam Negeri Sumatera Utara
Jl. William Iskandar Pasar V, Medan Estate, Kabupaten Deli Serdang, North of Sumatera, Indonesia, Postcode 20221

***Corresponding author:** yulierpiannaharahap@uinsu.ac.id

Submitted April 15th 2024 and Accepted June 29th 2024

Abstract

Higher Order Thinking Skills (HOTS) are skills needed in the 21st century education world that must be mastered and developed. Therefore, innovative open materials are needed to help develop higher-order thinking abilities. This development research aims to produce a valid, practical, effective student worksheet based on discovery learning. The instruments used were needs analysis in the form of teacher interview guidelines and questionnaires for students, media and material expert validation sheets, and practicality sheets. Then the effectiveness sheet was a pretest post-test sheet. Based on the results of the data analysis, the validation of teaching materials obtained a score of 96.15%, the results of material validation obtained a score of 88%, the results of the teacher response questionnaire obtained a score of 100%, and the results of the student response questionnaire obtained a score of 98.66%. The effectiveness assessment resulted in a score percentage of N -Get 71.88% in the high category. Therefore, the student worksheet based on discovery learning are considered a feasible, practical, and effective learning tool, facilitating the development of high-level thinking skills. However, further research development can expand the material on biology learning that has yet to be covered in developing the student worksheet and expand the research scale.

Keywords: *Discovery Learning; Higher Qrder Thinking Skills; Student Worksheet Development*

https://doi.org/10.36987/jpbn.v10i2.5865

INTRODUCTION

The 21st-century educational system integrates knowledge, skills, and attitudes. In the 21st century, the skills required in the field of education are higher-order thinking skills (HOTS) (Kemendikbud, 2016). According to King et al. (2018), HOTS encompass critical, logical, reflective, metacognitive, and creative thinking. Individuals activate all these skills when they encounter unfamiliar, uncertain, and question-filled problems. Furthermore, Brookhart (2010) defines high-level thinking as the following: analysis, evaluation, creation, logical reasoning, critical thinking, problem-solving, creativity, and creative thinking. The influence of higher-level thinking is significant because it enables students to endure the current global competition (Agus, 2018).

Nevertheless, the PISA assessment results in Indonesia indicate that critical thinking, problem-solving, and HOTS remain deficient. The low quality of learning that students engage in is indicative of the low level of HOTS (Muhlisah et al., 2023). The scores of Indonesian students are still below the 400-point threshold, which is equivalent to levels 2–3, according to PISA data (OECD, 2022). The weakness of Indonesian students is their inability to solve problems that necessitate critical, creative, and higher-order thinking skills, as indicated by the results of PISA 2016 (OECD, 2016).

The results of the MA YPI Batang Kuis biology teacher interview evaluation, which is consistent with the PISA assessment, indicate that students' HOTS abilities are still relatively low, particularly in the areas of analyzing and evaluating indicators. More frequently, the learning process applies the indicators to C1 through C4, with a question percentage of 25% for C1, 25% for C2, 25% for C3, and 15% for C4. Ramos et al., (2013) conducted research that indicates that HOTS (Higher Order Thinking Skills) are at a low level. This is because students often face difficulties in the analysis, evaluation, and creation processes due to a lack of relevant questions. Sobirin et al., (2016) found that only 12.5% of students successfully completed the HOTS (Higher Order Thinking Skills) category questions. In contrast, the LOTS (Lower Order Thinking Skills) category, which encompasses students' capacity to recall, comprehend, and apply information, achieved an impressive 87.5%.

Students learning process, which strictly instructs them to memorize, write, and complete exercises, contributes to their inadequate high-level thinking ability (Gusti & Syamsurizal, 2021). High-level thinking is no longer merely memorization; it also involves thinking integralistically, analyzing, and associating with concluding creative and productive ideas (Ernawati, 2017). The 2013 Curriculum recommends the Discovery Learning learning model, which is HOTS-oriented. Discovery learning is a model that involves an intuitive process to comprehend concepts, meanings, and relationships, ultimately leading to a conclusion (Fauzi et al., 2018). Anam (2015) posits that discovery learning can enhance students' self-efficacy and HOTS abilities by allowing them to employ their thinking skills to investigate the concepts presented to solve problems.

In order to facilitate an engaging learning experience, it is crucial to incorporate media (Tafonao 2018). Student worksheet is a method for assisting and facilitating learning activities. Astuti et al., (2018) have demonstrated that the student worksheet can enhance student activity by enhancing problem-solving and critical-thinking skills. Using the student worksheet can enhance students' HOTS, as per Verdina et al., (2018). Utilizing the discovery learning model in conjunction with the student worksheet can potentially enhance students' high-level thinking capabilities (Linda et al., 2019).

Rubiyanto et al., (2016) conducted prior research demonstrating the ability to elevate high school students' HOTS in class X science. Research by Rudibyani & Perdana (2018); Riandari et al., (2018); Haryati et al. (2017); Tondang & Sahyar (2016); and Wartono et al., (2018) shows that the use of the student worksheet based on discovery learning can improve HOTS. Muhammad (2022) also developed an e-student worksheet that is validated, practical, and effective in enhancing HOTS based on discovery learning. We have identified no prior research specifically addressing developing the student worksheet material in the reproductive system. Therefore, researchers have the opportunity to conduct research that focuses on developing student worksheet material in the reproductive system through discovery learning, aiming to enhance HOTS. The biology teacher at Senior High School of MA YPI Batang Quiz selected the reproductive system material for the quiz, citing it as one of the most challenging subjects for students. This decision was based on observations due to the abstract nature of the material and the difficulties associated with teaching it to prevent misunderstanding (Sridailani et al., 2018).

Based on the background, the MA YPI Batang Kuis school observations show that biology teachers more often use media in the form of worksheets. In contrast, HOTS implementation still needs to be improved. Indicators in the form of C1 to C4, even though the importance of higher level thinking, can build critical thinking skills, creativity, and trust self (Iskandar, 2015). Based on the background explanation, this research aims to develop the student worksheet learning media based on Discovery learning on reproductive system material to improve HOTS. From previous research, no research has been found that specifically discusses developing student worksheet with reproductive system material. With the hope of providing improved student learning outcomes and a valid, practical, and effective student learning process. Providing new variations in student learning requires them to be active and think highly.

METHOD

This investigation used a research and development (R&D) approach. This research was employed to develop worksheets for students based on discovery learning. The 4-D model (Thiagarajan et al., 1974) was employed as the approach model, consisting of defining, designing, developing, and disseminating. Nevertheless, the scope of this investigation was restricted to the development phase due to financial and time constraints.

This research was carried out at MA YPI Batang Kuis, with 25 students as research subjects in class XI YPI Batang Kuis. The research instrument used was needs analysis in the form of interview sheets for teachers and student needs analysis questionnaires. Then, a validation sheet consisting of media expert validation sheets and materials was used to test the validity of the media, and a response questionnaire for students was used as an instrument to test the practicality of the media. Meanwhile, to measure the effectiveness of the student worksheet, a student HOTS ability measurement sheet was used in the form of 10 essay questions that had been validated. The validation results were found to be very effective, with a score of 71.88%.

This 4D development model commenced with the definition stage, which involved the initial analysis of the facts that emerge to ascertain the product's suitability for development. This analysis included student analysis, task analysis, concept analysis, and the formulation of learning objectives. The second stage of the design process was selecting the presentation format and determine the media/product to be developed, which was a the student worksheet based on discovery learning. The development stage was associated with evaluating the student worksheet's feasibility in the third stage. A material feasibility questionnaire and a design feasibility questionnaire were implemented.

The data analysis technique in the validity test used a Likert scale with a range of 1 to 5, and each question had a choice of 1 to 5 with the following formula 1 (Ikhwani & Kuntjoro, 2021):

$$\mathrm{P} = \frac{The\ total\ score\ of\ the\ answers\ for\ each\ score}{the\ number\ of\ ideal\ item\ scores}\ X\ 100\% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ (1)$$

The results obtained are interpreted using the following criteria: 0-20 is not valid, 21-40 is not valid, 41-60 is quite valid, 61-80 is valid, and 81-100 is very valid (Dermawati et al., 2019). To calculate the percentage of students who responded to each category asked in the questionnaire, use the 2 percentage correction formula (Purwanto, 2012) as follows:

$$\mathrm{N}P = \frac{R}{SM}\ X\ 100\% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ (2)$$

Information:
NP : Expected Percentage Value
R : Score obtained
SM : Maximum score

After the percentage was obtained, grouping was done according to the criteria for achieving practicality. Student responses were said to meet the practical criteria if they were at an 81-100% achievement level. Practical if 61-81%. Less practical 41-60%. Not practical 2-40%, and less than 21% very impractical (Husnita & Saputri, 2023). Effectiveness analysis was based on student achievement when completing learning outcomes tests. Measuring the effectiveness of newly developed products using pre-test and post-test tests on students during field tests. To find out whether or not the

developed student worksheet was successful in increasing learning outcomes, a comparison of the normalized N-gain values or N-gain equation was carried out:

$$\text{N-gain (\%)} = \frac{(Post{-}test\ Score - Pre{-}test\ Score)}{(Max\ Score - Pre{-}set\ Score)}\ x\ 100 \quad \ldots\ldots\ldots\ldots\ldots (3)$$

The normalized gain score results were divided into three categories, namely N-gain <0.3 less effective, 0.3≤ N-gain ≤0.7 quite effective, and N-gain > 0.7 Effective (Yunipiyanto et al., 2020).

RESULTS AND DISCUSSION

This development research produced teaching media as student worksheet based on discovery learning on reproductive system material. Student worksheet based on discovery learning was created for student collaboration and higher-level thinking. This research uses 4 stages based on the 4D development model (Thiagarajan, 1974). The following explains the findings of the stages of student worksheet development in this research.

Defined

The definition stage consists of five main steps: initial analysis, student analysis, concept analysis, task analysis, and goal analysis. This stage is intended to recognize and define needs in the learning process.

a. Front-End Analysis

Front-end analysis is the analysis that underlies development research. Initial analysis was done by analyzing biology learning conditions at MA YPI Batang Kuis. The initial analysis was carried out through interviews with biology teachers and questionnaires to analyze the needs of teachers and students. Observation results show that the learning process still uses the 2013 curriculum, teachers still use the lecture method, and there is still a lack of media in the learning process, namely in the form of the student worksheet, so it is essential to develop media in the form of student worksheet based on learning models to improve students' high-level thinking abilities. According to Nugroho (2018), HOTS-based student worksheet has a very positive influence on improving high-level thinking abilities, which can increase students' learning motivation.

b. Student Analysis

Student analysis is applied to determine students' subject needs to support the implemented learning process. Findings from the student needs analysis questionnaire showed that the learning process could have been more attractive, there was a lack of media, and students were still unfamiliar with HOTS-based questions. It is evident from the worksheets used by students that they still minimally discuss HOTS questions C4 (analyzing), C5 (evaluating), and C6 (creating). Meanwhile, the indicators used in

learning more often apply C1 to C4, with a relatively small percentage of questions of 25% for C1, 25% for for C2, 25% for for C3, and 15% forand for C4.

c. Concept Analysis

The defining step of this 4D development model begins with the preliminary examination of the facts that surface in order to determine whether the product is suitable for development. The creation of learning objectives, task analysis, concept analysis, and student analysis are all included in this analysis. Choose the format for the presentation and decide on the media or product to be created in the second design stage. The student worksheet will be based on exploration learning. The third stage's assessment of the student worksheet's viability is linked to the development stage. Two questionnaires were used: one for material feasibility and the other for design feasibility.

d. Task Analysis

Task analysis is a method used to identify activities and activities that have the potential to affect students' HOTS. In order to conduct this analysis, indicators of competency achievement in KD 4.12 were developed. These indicators involved presenting the findings of a review of the literature on the effects of diseases, promiscuity, and anomalies in the structure and function of organs that result in disorders of the human reproductive system. Task analysis activities' competency achievement indicators are shown in Table 1.

Table 1. Competence Achievement Indicators

Basic Competence (KD)	Competency Achievement Indicators (IPK)
4.12 Presenting the results of an analysis of the impact of promiscuity, disease and abnormalities on the structure and function of organs that cause disruption to the human reproductive system and reproductive system technology	4.12.1 Reviewing the literature on the effects of promiscuity 4.12.2 Presenting the findings of an investigation of the effects of sickness, promiscuity, and anomalies on the anatomy and physiology of organs that affect the human reproductive system and its technological advancements

e. Learning Objective Analysis

Currently, the HOTS indicators-abilities C4 (analysis), C5 (evaluation), and C6 (creation) in accordance with Bloom's taxonomy-form the basis for learning objectives. The intended learning outcomes and the findings of the analysis are taken into account when adjusting the learning objectives. The student worksheet, which is focused on exploration learning, has the following learning objectives that must be met:

1) Students can identify the function of organs in the male and female reproductive systems through discussion activities and literature review.
2) Students can analyze the process of formation of male sex cells (spermatogenesis) through discussion activities and literature studies.
3) Students can analyze the process of formation of female sex cells (oogenesis) through discussion activities and literature studies.
4) Students can analyze the process of ovulation and menstruation through discussion and literature review activities.
5) Students can analyze the process of fertilization, pregnancy and childbirth through literature review and discussion activities.
6) Students can evaluate disorders/abnormalities related to the reproductive system through literature review and discussion activities.

Figure 1. The cover

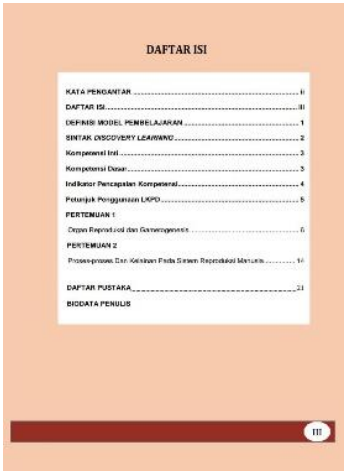


Figure 2. The contentc list

Figure 3. The instructions

Figure 4. The Material

Design

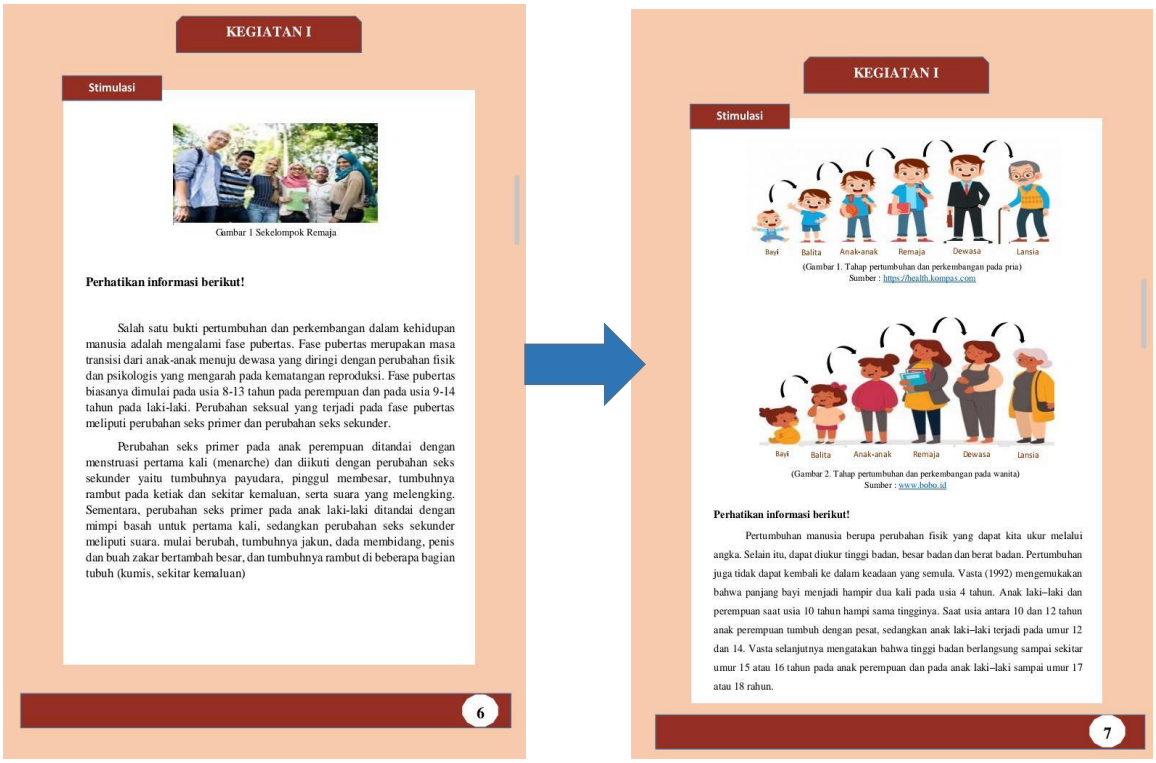
Researchers started designing the elements of the student worksheets based on discovery learning during the design stage. This included thinking about the appearance, content, language, and fit of the worksheets to the problem-based learning model. The student worksheet cover, presentation of core competencies, basic competencies, indications, learning instructions, and content presentation with pertinent picture media are the first steps in the development of the final product. At this stage, the student workesheets based on discovery learning is designed in the form of color gradations and attractive images using the Canva and Microsoft Word applications.

Development of product

The actions related to product development and validation are completed in the third stage, which is called the develop stage. The outcomes of the validation process, which involved media and material experts, are displayed in Table 2. After conducting development and receiving numerous suggestions from validators during revision, the media and the teaching material experts obtained validation results of 96.15%. This implies that the exploration learning-based student worksheet is really valid. Before field trials are conducted, the feasibility of the student worksheet based on discovery learning is to be determined through the suggestions and responses of validators. The assessment of validity can be observed from a variety of perspectives, including content, presentation, language, and visual appearance (Mutmainah et al., 2022). Furthermore, the 88% material expert validation findings demonstrated the excellent validity of the student worksheet. The content that is associated with students' daily lives is accompanied by the material that is presented with high scores.

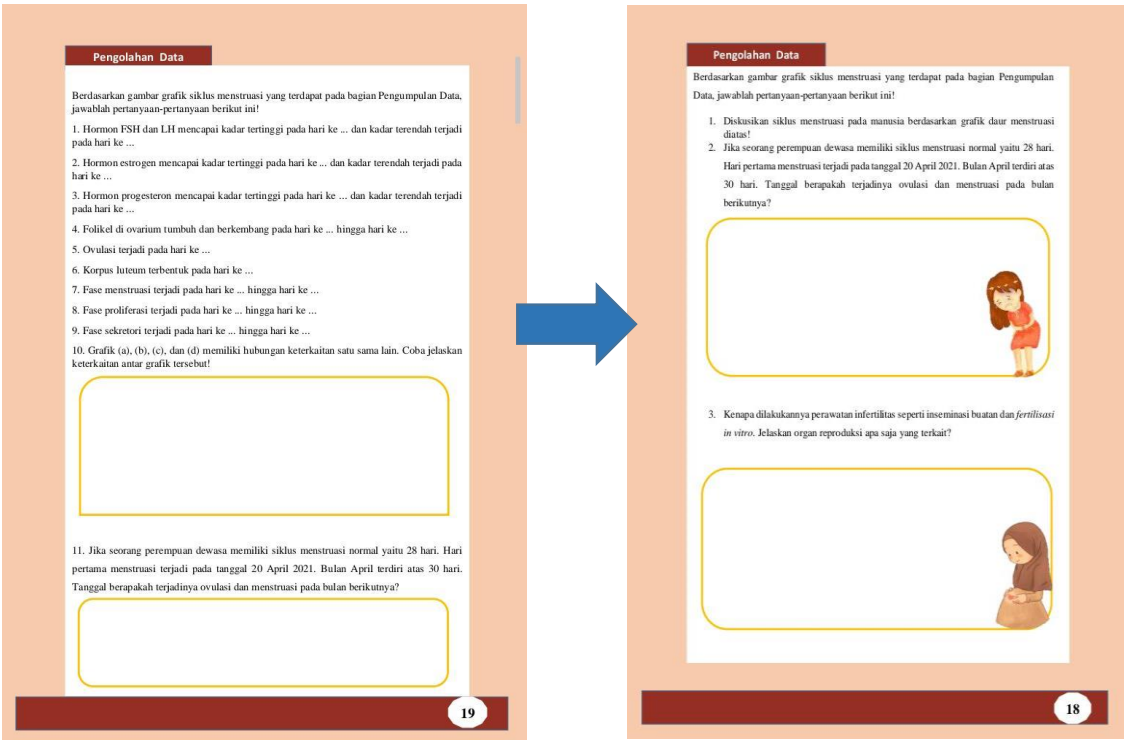
Table 2. Media and Material Validation Results

Aspect	**Percentage**	**Category**
Validation of the media and the teaching material experts	96,15%	Highly valid
Validation of the material experts	88 %	Highly valid
Category		**Highly Valid**



Gambar 5. Image improvements based on validators' suggestions so the image is clearer and more detailed

Gambar 6. Improved video link material so it is replaced with a QR code



Gambar 7. Improved questions to be replaced according to HOTS-based questions

The material is presented in a manner that is relevant to real life, as per the research conducted by Widjajanti (2014), to ensure that students are accustomed to independently solving problems and making decisions. It is possible to engage students in teaching and learning activities by creating student worksheet based on discovery learning and feature visually appealing designs. This is consistent with prior research, which has shown that the implementation of an engaging learning design can pique students' interest in completing the student worksheet and provide feedback to encourage active participation during the discussion (Mayasari, 2022). Nevertheless, as shown in Figures 5, 6, and 7, the student worksheet was enhanced by media experts as well as material experts in compliance with the validator's recommendations. Once the instructional materials are deemed valid, instructor and student responses to questionnaires are distributed in a small-scale trial. The data about the practicality of teacher and student responses are displayed in Table 3.

Table 3. Teacher and Student Responses

Respondent	**Percentage**	**Category**
Biology teacher	100 %	Highly Practical
25 students	98,66%	Highly Practical
Category		**Highly Practical**

Based on the biology teacher's response questionnaire, the student worksheet is stated to be very practical for use in learning with a percentage of 100%. Because the student worksheet can be used in the learning process, it comes with supporting material to help students understand the concept, the writing style is easy to read, and the use of images in each section of the worksheet helps students understand the material's structure, it was classified as practical. This is in accordance with the statement by Firdaus & Wilujeng (2018) in their research that the use of clear and attractive images in the student worksheet can make it easier for students to understand learning material.

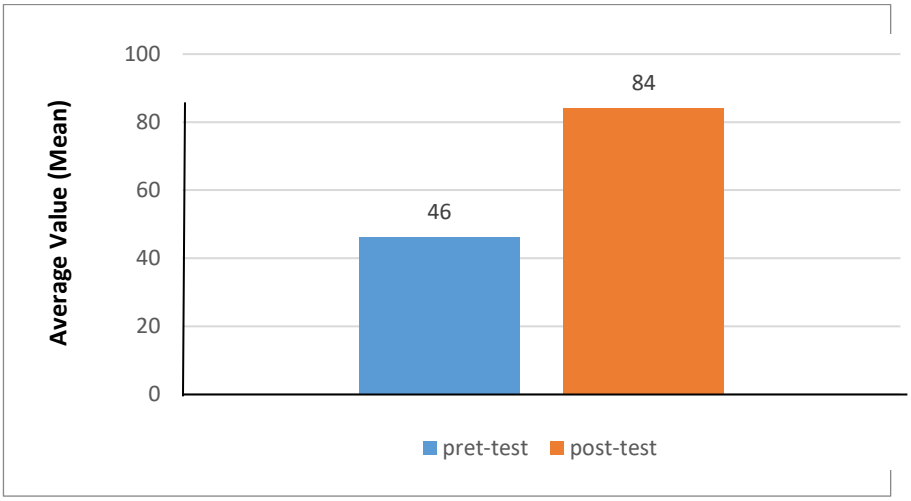
Meanwhile, With a score of 98.66%, it is known that the student questionnaire findings were classified as highly practical, this is in accordance with the research assessment criteria carried out by Zonita (2013) which states that a score of 80% -100% is included in the very practical criteria. Based on the quite favorable or good student responses, the research results demonstrate that using the student worksheet based on exploration learning has a positive link with student responses. This is in line with research conducted by Khartaningtyas & Rosdiana (2020) which states that if students give a good or positive response then the student's learning outcomes are also in the good category.

After the validation and practicality process, an effectiveness test was carried out in 1 class at MA YPI Batang Kuis. Pretest-posttest analysis, which measures students' high-level thinking skills, demonstrates the efficacy of the student worksheet based on discovery learning (Figure 5). To see the effectiveness of students' high-level thinking abilities, see Table 4. The results of the N-Gain calculation show that the students' pretest scores are lower. compared to the post-test value, with an N-Gain value percentage of 71.88%, which shows the effective category level. It is possible to say that students can think freely since the pretest-posttest questions ask participants to relate the subject to a real-world problem. This allows students to propose answers. In line with other research, open thinking can increase students' imagination (Makhmudah, 2018).

Table 4. Students' HOTS

Pre-test	Post-test	N-Gain %	Criteria
46,3	84.9	71,88 %	Effective

The purpose of the effectiveness test was to raise students' levels of critical thinking, as indicated by their performance on the class XI pretest and posttest. Ten questions each of the three HOTS indicators—C4 (analysis), C5 (evaluation), and C6 (creating)—found in the pretest and posttest are based on these indicators. After learning activities using the created media, namely the student worksheet based on discovery learning, better outcomes were obtained.



Gambar 5. Diagram Pretest-Posttest

Students' high-level thinking abilities can be trained by getting used to giving hot questions or those that require problem-solving (Saraswati & Agustika, 2020). As with research conducted by Yuliantaningrum & Sunarti (2020), the results show that using hot questions can stimulate students' high-level thinking abilities. The results of this research align with Dewi et al., (2020) by obtaining the results that developing HOTS-based question sheets can improve high-level thinking abilities.

Implementing learning using the student worksheet learning media based on discovery learning has proven effective in increasing students' HOTS because implementing discovery learning involves syntax that can make students active in learning activities, with discovery activities and thinking to solve existing problems. This is in line with the results of research conducted by Rahayu & Hardini (2019), which proves that the application of discovery learning can increase student activity and learning outcomes if implemented correctly by understanding all the steps for implementing the discovery learning learning model.

Students learn in groups of four to five, carrying out different steps in the grammar of discovery learning as they carry out the learning process. Andi (2022) believes that group learning will help students meet their learning needs because it makes it simple for students to get answers based on the outcomes of their discussion activities, which allows the required learning objectives to be well achieved. Based on the implementation of the research, it was found that students were active in group learning when solving a problem with their group friends. The success of the teacher's instruction is reflected in the learning of the students.

The discovery learning-based student worksheets are appropriate for the learning process because their efficacy has been demonstrated by outcomes in the high N-Gain category. It has been demonstrated that applying discovery learning increases HOTS; the useful outcomes support this claim are examinations given to students prior to the

start of the learning process utilizing the student worksheet, on which scores are collected. The average of students related to HOTS was meager, and the posttest carried out after learning to use the student worksheet increased. This proves that the student worksheet based on discovery learning can increase students' HOTS, which is in line with the opinion of Sulastri (2020), who proves that HOTS-oriented learning by implementing discovery learning can build students' understanding. Nur & Masita (2022) also argue that the student worksheet based on discovery learning can support teachers in providing active learning, especially for students, and make it easier for them to learn. Therefore, by means of validation tests, the usefulness and efficiency of the student worksheet grounded in discovery learning can raise students' HOTS by means of training questions that encourage students to engage in critical analysis, evaluation, and creativity with the many discoveries and conversations.

CONCLUSION

In light of the study that has been done, The goal of the discovery learning-based student worksheets is to produce reliable, useful, and efficient teaching resources that will raise students' critical thinking abilities when it comes to the subject of the reproductive system. It is conceivable, useful, and successful to create a student worksheet based on discovery learning in order to help students develop higher order thinking skills. However, this research still has limitations and aspects of testing for a larger population scale and varying ability measurement variables. Therefore, the researcher suggests that future researchers expand the population reach in implementing the student worksheet based on discovery learning in schools, varying the biology material taught and measuring other aspects of 21st-century skills.

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How To Cite This Article, with *APA style* :

Harahap, Y.E., & Jayanti, U.N.A.D. (2024). Development of Student Worksheet based on Discovery Learning on Reproductive System Materials in Improving Higher Order Thinking Skills of Senior High School level-Madrasah Aliyah (MA) Students. *Jurnal Pembelajaran dan Biologi Nukleus*, 10(2), 664-681. https://doi.org/10.36987/jpbn.v10i2.5865

Conflict of interest : The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author contributions : All authors contributed to the study's conception and design. Material preparation, data collection and analysis were performed by all authors. The first draft of the manuscript was submited by [Yuli Erpianna Harahap]. All authors contributed on previous version and revisions process of the manuscript. All authors read and approved the final manuscript.