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Development of Discovery Learning-Based Student Worksheet Assisted by Canva on Chemical Equilibrium Material to Enhance Students' Higher Order Thinking Skills

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Abstract: Development of Discovery Learning-Based Student Worksheet Assisted by Canva on Chemical Equilibrium Material to Enhance Students' Higher Order Thinking Skills. This research aims to develop a Student Worksheet based on Discovery Learning assisted by Canva on the topic of Chemical Equilibrium to enhance students' Higher Order Thinking Skills. The study employs the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development model. The sample for this research consisted of 35 students from class XI A at SMA Negeri 1 Galang. The research instruments used included validation sheets from material and media experts, student response questionnaires, as well as pretest and posttest questions to measure the improvement in students' Higher Order Thinking Skills. The results of the study indicate that the developed Student Worksheet was declared highly valid according to BSNP standards and suitable for use in the learning process. The average validation score from material experts was 88.64%, and from media experts, it was 86.66%. To assess the effectiveness of the Student Worksheet, a trial was conducted by administering pretests and posttests to the students. The results showed a significant improvement, with the average pretest score of 18.28% increasing to 81.42% in the posttest. The N-Gain score of 0.77 (77%) falls into the high category, indicating that the developed Student Worksheet is highly effective in enhancing students' Higher Order Thinking Skills. Additionally, student responses to the Student Worksheet showed a very high level of satisfaction, with an average percentage of 93%. Therefore, the Discovery Learning-based Student Worksheet developed in this study is not only suitable as a learning medium but has also proven to be effective in improving students' Higher Order Thinking Skills on the topic of Chemical Equilibrium.

Keywords: Student worksheet, discovery learning, canva, chemical equilibrium, Higher Order Thinking Skills.

Abstrak: Pengembangan Lembar Kerja Peserta Didik berbasis Discovery Learning berbantuan Canva pada materi Kesetimbangan Kimia untuk meningkatkan Higher Order Thinking Skills siswa. *Penelitian ini bertujuan untuk mengembangkan Lembar Kerja Peserta Didik berbasis Discovery Learning berbantuan Canva pada materi Kesetimbangan Kimia untuk meningkatkan Higher Order Thinking Skills siswa. Penelitian ini menggunakan model pengembangan ADDIE (Analysis, Design, Development, Implementation, and Evaluation). Sampel dalam penelitian ini adalah siswa kelas XI A SMA Negeri 1 Galang yang berjumlah 35 siswa. Instrumen penelitian yang digunakan meliputi lembar validasi ahli materi dan ahli media, angket respon siswa, serta soal pretest dan posttest untuk mengukur peningkatan Higher Order Thinking Skills siswa. Hasil penelitian menunjukkan bahwa Lembar Kerja Peserta Didik yang dikembangkan dinyatakan sangat valid dan standar BSNP, serta layak digunakan dalam proses pembelajaran. Dengan rata-rata nilai hasil validasi ahli materi sebesar 88,64%, dan ahli media*

86,66%. Untuk melihat keefektifan Lembar Kerja Peserta Didik, dilakukan uji coba dengan memberikan pretest dan posttest kepada siswa. Hasilnya menunjukkan peningkatan signifikan pada kemampuan Higher Order Thinking Skills siswa, dengan skor rata-rata pretest sebesar 18,28% meningkat menjadi 81,42% pada posttest. Skor N-Gain sebesar 0,77 (77%) termasuk dalam kategori tinggi, yang mengindikasikan bahwa lembar kerja peserta didik yang dikembangkan sangat efektif dalam meningkatkan Higher Order Thinking Skills Siswa. Selain itu, respon siswa terhadap Lembar Kerja Peserta Didik menunjukkan tingkat kepuasan yang sangat tinggi dengan rata-rata persentase 93%. Dengan demikian, Lembar Kerja Peserta Didik berbasis Discovery Learning hasil pengembangan ini tidak hanya layak digunakan sebagai media pembelajaran, tetapi juga terbukti efektif dalam meningkatkan Higher Order Thinking Skills siswa pada materi Kesetimbangan Kimia..

Kata kunci: *Lembar Kerja Peserta Didik, discovery learning, canva, kesetimbangan kimia, Higher Order Thinking Skills*

• INTRODUCTION

Education plays a crucial role in determining the quality of human resources. Essentially, education is an effort to equip individuals with knowledge, skills, and insights so that they can develop various forms of abilities, such as their potential, talents, interests, and personality (Putra et al., 2023). In the era of the Industrial Revolution 4.0 moving towards 5.0, education is directed towards the development of mathematical abilities aligned with the 21st century (Oktavia et al., 2019). Learning in the 21st century uses the term 4C (critical thinking, communication, collaboration, and creativity). These four skills are essential and necessary for education and are part of higher-order thinking skills (HOTS) (Ariyana et al., 2018). HOTS encompasses aspects of knowledge that include indicators such as understanding, applying, analyzing, and evaluating (Purwasi & Fitriyana, 2020).

The implementation of HOTS in Indonesia has not yet been maximized, as evidenced by Indonesia's ranking in the Programme for International Student Assessment (PISA) test. This test measures the scientific and mathematical literacy of middle school students and reflects the quality of a country's HOTS. Based on the 2022 PISA survey results, Indonesia's reading, mathematics, and science abilities are categorized as low, ranking 69th out of 80 countries. According to PISA data, the scores of Indonesian middle school students are still below the threshold of 400, equivalent to levels 2 and 3 (Marwah & Pertiwi, 2024). Only about 1% of middle school students are able to reach the highest levels, namely levels 5 and 6. This indicates the low quality of learning conducted in schools (Putrawangsa & Hasanah, 2022).

Chemistry is a subject that studies the properties of substances or materials and their applications in daily life. Concrete and abstract chemical concepts are difficult to visualize, making it challenging for students to understand them (Al-Nakhle, 2022). In chemistry learning, it is not only about mastering conceptual knowledge but also about the discovery process that involves process skills and thinking through scientific methods (Syam & Kurniasih, 2023). Chemistry, which involves process skills, includes ways of thinking, reasoning, formulating problems, conducting experiments and observations, analyzing data, and drawing conclusions to obtain scientific products that are considered capable of training HOTS (Sapriati et al., 2023). Teachers play a role in implementing active learning to enhance students' HOTS, such as analyzing, evaluating, experimenting, and creating (Syam & Kurniasih, 2023). HOTS is one of the required skills in 21st-

century learning. Additionally, these skills can be developed through experimental activities conducted in study groups, both in classroom learning and extracurricular activities (Purjiyanta & Herni, 2019).

Based on interviews conducted with chemistry teachers at SMA Negeri 1 Galang, it was stated that teachers use discussion and lecture methods and explain material on the blackboard, making learning teacher-centered rather than student-centered. This is one of the factors influencing students' low interest in chemistry, especially in chemical equilibrium material, as it is quite difficult and abstract. Particularly in determining the direction of chemical equilibrium shifts, students are required to determine the direction of equilibrium shifts based on influencing factors to keep the reaction in equilibrium. This results in the lack of enhancement of students' HOTS and learning outcomes in the learning process. Students state that chemistry is a difficult subject, and sometimes they do not understand the material explained by the teacher. Lack of understanding of the material concepts can trigger low HOTS in students (Faizzah & Sutarni, 2023).

The learning process will not align with chemistry learning if students only understand chemistry by memorizing without gathering meaningful knowledge and concepts. One effort that needs to be made is the innovation of the learning process through the application of discovery learning-based Student Worksheets to enhance students' HOTS. Student Worksheets are examples of innovative teaching materials (Suryaningsih & Nurlita, 2021). Student Worksheets is needed by teachers as one solution to improve higher-order thinking skills and student learning outcomes (Julian & Suparman, 2019). According to Ichsan (2022), Student Worksheets is a printed teaching material in the form of sheets of paper containing material, summaries, portfolios, practice questions, and instructions that can engage students actively in the learning process. Discovery learning-based Student Worksheets is suitable for training students to work scientifically. This model is used to assist educators in improving and enhancing students' thinking abilities and cognitive processes while learning the material. Discovery learning-based Student Worksheets is one of the alternative learning methods suitable for improving students' HOTS as it creates a more active learning situation in discovering concepts through learning activity stages.

Information and computer technology has developed rapidly and has had a tremendous influence as time progresses. All aspects of life, including education, have advanced. This can be seen in the implications for the development of learning media that now utilize computers and the internet (Fatayah, 2023). The researcher intends to develop discovery learning-based Student Worksheets assisted by Canva. Canva is an online design tool that works using computers, laptops, and smartphones, which can help make product development more attractive. The use of Canva can facilitate and save time for educators in designing learning media and other teaching tools (Said et al., 2023).

Based on research conducted by (Nurlian et al., 2023), it shows that discovery learning-based Student Worksheets is suitable for use as teaching material with scores on aspects of content feasibility, language, and presentation at 90.57% (very good). Meanwhile, the results of student response analysis show a very good category with a score of 89.19%. Meanwhile, research conducted by (Auliyah et al., 2024) on the application of discovery learning-based Student Worksheets on Elasticity and Hooke's Law material can improve students' understanding and learning outcomes with an N-Gain of 88%. In line with the results of research by (Dwi et al., 2023), which focuses on the development of Student Worksheets to improve students' HOTS and creative thinking skills on stoichiometry material, it shows that the developed Student Worksheets can

improve students' creative and critical thinking skills with an N-gain of 0.83 and is effective with an N-gain value of 0.40. Based on validation results, it shows a very valid category with a score of 89.95%, very practical with a score of 87.6%, and very effective with a score of 83%. These results conclude that the application of Student Worksheets can improve students' higher-order thinking skills. Therefore, this research needs to be conducted.

• METHOD

Types and Research Models

This research employs a Research and Development (R&D) approach, utilizing the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) (Nurmalasari et al., 2022). This model was chosen because it is rational, systematic, comprehensive, and easy to understand in the process of developing learning media (Indartiwi et al., 2020).

Research Design

The research design used is the One Group Pretest-Posttest Design, which was chosen because it involves only one group or class as the research sample. The research design of the one group pretest-posttest can be seen in Table 1.

Table 1. One Group pretest-posttest research design

Gruop	Pretest	Treatment	Posttest
Eksperimen	T_{1a}	X	T_{2a}

Description:

X : Treatment or intervention provided.
T_{1a} : Initial measurement (pretest) before treatment.
T_{2a} : Final measurement (posttest) after treatment.

Time and Location of the Research

This research was conducted at SMA Negeri 1 Galang, located at Jl. Mawar II No. 1, Galinda Complex, Galang District, Deli Serdang Regency, North Sumatra Province. The research is planned to be carried out over four months, from October 2024 to January 2025.

Population and Sample

The research population includes all 11th-grade students of SMA Negeri 1 Galang in the even semester of the 2025 Academic Year, consisting of seven classes (XI A to XI G) with a total of 240 students. The research sample is the students of class XI A, totaling 35 individuals.

Data Collection Techniques

Data collection techniques include interviews, questionnaires, tests, and documentation. Interviews were used to gather information about the school's conditions, problems, and obstacles in the learning process. Questionnaires were given to product validators, consisting of one media expert lecturer, one material expert lecturer, and one chemistry teacher. The questionnaire for the media expert aimed to assess the feasibility

of the student worksheet, while the questionnaire for the material expert was used to evaluate the alignment of the Student Worksheets content with the learning objectives and indicators. Additionally, questionnaires were also given to students to determine their responses to the use of the Student Worksheets. A written test in the form of 20 multiple-choice questions (C4, C5, C6) as a pretest-posttest was administered to class XI A students to measure the improvement of Higher Order Thinking Skills on chemical equilibrium material after using the discovery learning-based Student Worksheets. Documentation was used to collect physical evidence during the research process.

Data Analysis

The data obtained from the validation questionnaires of media and material experts will be analyzed using descriptive analysis techniques with a Likert scale scoring system divided into four categories.

Tabel 2. Criteria for validation instrument item responses using likert scale

NO.	Answer	Score
1.	Disagree	1
2.	Slightly Agree	2
3.	Agree	3
4.	Strongly Agree	4

(Mardianto et al., 2022).

To calculate the validity of the validation results from each expert, the following formula is used:

$$P(s) = \frac{f}{N} x100\%$$

Description:
P(s) : Percentage of the sub-variable
F : Total score obtained from the responses
N : Maximum total score (Widoyoko, 2016).

From the percentage results obtained, the next step is to classify the percentage of each variable into the percentage range table of qualitative criteria, as shown in Table 3.

Tabel 3. Percentage range of qualitative criteria for expert validation

Score	Kategori
81,25% > Score ≤ 100%	Very Feasible
62,50% > Score ≤ 81,25%	Feasible
43, 75% > Score ≤ 62,50%	Moderately Feasible
25% ≥ Score ≤ 43,75%	Less Feasible

(Modified Fatayah, 2023)**.**

The data obtained from the student response questionnaires will be analyzed using descriptive analysis techniques with a Likert scale scoring system divided into four categories. To calculate the student response questionnaire results, the following formula is used:

$$P(s) = \frac{f}{N} x100\%$$

Description:
P(s) : Percentage of the sub-variable
F : Total score obtained from the responses
N : Maximum total score

From the percentage results obtained, the next step is to classify the percentage of each variable into the percentage range table for qualitative criteria, as shown in Table 4.

Table 4. Percentage range for qualitative criteria

Score	Category
81,25% > Score ≤ 100%	Very Satisfied
62,50% > Score ≤ 81,25%	Satisfied
43, 75% > Score ≤ 62,50%	Less Satisfied
25% ≥ Score ≤ 43,75%	Not Satisfied

(Modified Fatayah, 2023)**.**

The data analysis to test the effectiveness of the product uses the results of the pretest, posttest, and gain score. The gain is the difference between the pretest and posttest scores. The formula for the normalized gain is as follows:

$$Normalized\ Gain\ (N-Gain) = \frac{Postest\ score - Pretest\ score}{Maximum\ score - Pretest\ score}$$

The N-Gain score can be classified according to Table 5.

Table 5. Criteria for Normalized Gain

Nilai	Category
0,70≤**g**≤1,00	High
0,30≤**g**≤0,70	Moderate
0,00≤**g**≤0,30	Low

(Sundayana, 2014).

▪ RESULT AND DISCUSSION

In this research, the development of the Student Worksheet media was carried out through the application of the ADDIE method (Analysis, Design, Development, Implementation, and Evaluation).

ANALYSIS

This stage is the initial phase conducted by the researcher to determine and define the requirements for learning. This stage is useful for analyzing the needs in the learning process and gathering various information related to the Student Worksheets being developed. This stage is divided into several steps, namely:

1. Initial-Final Analysis

The initial analysis was conducted by observing at SMA Negeri 1 Galang, specifically focusing on grade XI students. The observation was carried out through direct observation, interviews with chemistry teachers, and several students. At this stage, the

researcher identified the problems faced by the school, teachers, and students. The problems identified at the school level include the lack of laboratory facilities. The inadequate availability of laboratories hinders the chemistry learning process, especially for materials that require practical work.

The problem faced by teachers is the absence of discovery learning-based Student Worksheets media, particularly for the chemical equilibrium material. In the learning process, teachers still use discussion and lecture methods (conventional), which are less effective in encouraging students to think actively and creatively in discovering concepts through exploration and investigation (Meyanti et al., 2019). This results in a passive learning process that minimally involves students in the concept discovery process, thereby reducing students' interest and understanding of the material being taught.

The problem faced by students is the difficulty in understanding concrete and abstract chemistry concepts, as well as feeling bored due to the teacher-centered learning approach. These difficulties can lead to low student motivation and suboptimal learning outcomes. Based on interviews with chemistry teachers, the problems identified are summarized in Table 6.

Tabel 6. The problems faced by teachers from the interview results

No.	Problems
1.	The practical facilities are inadequate.
2.	Students consider chemistry to be a difficult subject.
3.	The Student Worksheets used only contain material and practice questions.
4.	The Student Worksheets is lacking in the application of chemical experiments in learning and the steps of the students' work procedures.

Based on the data in Table 6, it was obtained from interviews with the teacher that the researcher concluded that students are usually given worksheets containing only material and practice questions without experiments or step-by-step instructions. As a result, students are less trained in finding answers independently to solve problems. To address this issue, engaging Student Worksheets are needed in the learning process, and discovery learning-based Student Worksheets can be a solution to increase students' interest and understanding. The discovery learning method emphasizes a learning process that actively involves students in discovering concepts through exploration and investigation (Syahputri et al., 2023). By using discovery learning-based Student Worksheets, students are not just passive recipients of information but are directly involved in experiments, observations, and data analysis. This aligns with previous researchers' opinions that discovery learning-based Student Worksheets media will make learning more interactive, engaging, and meaningful, thereby increasing students' interest in chemistry (Safitri et al., 2020). Additionally, this approach encourages students to think critically, analytically, and creatively, which are part of Higher Order Thinking Skills (Ernawati, 2017).

2. Curriculum Analysis

At this stage, curriculum analysis, learning outcomes, and learning objectives are conducted. There are two types of curricula applied in schools: the 2013 curriculum for grade XII and the Merdeka curriculum for grades X and XI.

3. Concept Analysis

Concept analysis at this stage is carried out by identifying the key concepts of the chemistry material to be taught, organizing them hierarchically, and detailing these concepts according to the applicable curriculum. Concept analysis is an important step in learning planning as it relates to mapping the material students will learn. This process involves creating concept maps that systematically and structurally illustrate the relationships between concepts. These concept maps will help students understand the subject matter more easily, as they can visually and logically see the connections between one concept and another.

DESIGN

The Design phase aims to create the Student Worksheet to be developed. The steps to be taken in this stage are as follows:

1. Material Compilation

At this stage, the researcher selects material that aligns with the curriculum used at SMA Negeri 1 Galang. The material presented and developed in the discovery learning-based student worksheets to enhance students' Higher Order Thinking Skills is Class XI material on chemical equilibrium. The next step is to gather material from various accurate sources. The material included in the Chemical Equilibrium student worksheets consists of dynamic equilibrium, equilibrium constants, shifts in equilibrium, and the application of chemical equilibrium concepts. The model used is the discovery learning model. Cahyaningsih & Assidik (2021) state that discovery learning is a learning approach that focuses on the active role of students in independently discovering knowledge through experiments or direct observation. In this method, students are encouraged to actively engage in learning activities, so they are not just passive recipients of information but also develop critical and creative thinking skills. Thus, discovery learning creates a dynamic learning environment and encourages students to become more independent in understanding the concepts being studied. Therefore, it is important to evaluate the effectiveness of using discovery learning-based student worksheets in enhancing students' Higher Order Thinking Skills.

2. Format Selection

The chosen format includes paper type, size, and font style. The paper type used is A4 (21 x 29.7 cm). The font style is Open Sans with sizes of 12 pt, 14 pt, and 15 pt. For the title on the student worksheets cover, two font styles are used: Agrandir and Roboto Condensed, with sizes of 25 pt and 103 pt, respectively.

a) Student Worksheets Cover

The cover of the student worksheets includes the product name, which is the Discovery Learning-Based Student Worksheet on Chemical Equilibrium, as well as images related to the material. The student worksheets cover can be seen in Figure 1.

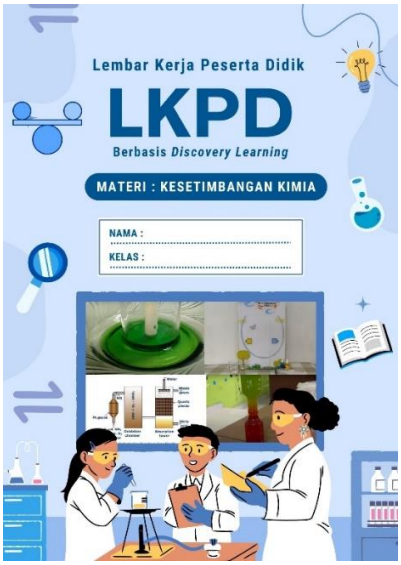


Figure 1. Front Cover Display of the student worksheets

b) Content of the Material

The content of the material in this student worksheets is equipped with a preface, table of contents, instructions for using the student worksheets, learning objectives, learning pathways, concept maps, activity steps, questions, and supporting images and videos. The display of the student worksheets content can be seen in Figure 2.

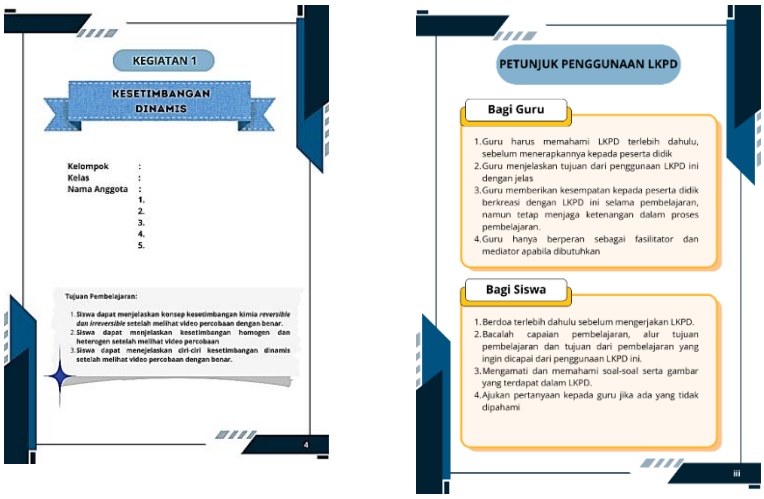


Figure 2. Display of the student worksheets content

c) Preparation of Research Instruments

The research instruments prepared by the researcher aim to collect information that can be used, particularly to assess the feasibility of the product based on evaluations by media experts and material experts. Below is the structure of the instruments that have been designed and validated:

1. Material expert assessment sheet consists of 20 questions, with 4 available responses: (4) strongly agree; (3) agree; (2) disagree; (1) strongly disagree.
2. Media expert assessment sheet consists of 20 questions, with 4 available responses: (4) strongly agree; (3) agree; (2) disagree; (1) strongly disagree.
3. Student response sheet consists of 10 questions, with 4 available responses: (4) strongly agree; (3) agree; (2) disagree; (1) strongly disagree.

DEVELOPMENT

At this stage, the researcher has successfully produced the product that was previously planned for development. Several steps taken in this development phase include the evaluation process by media expert lecturers and material expert lecturers.

Results of Material Expert Evaluation

The material validation of the student worksheets aims to obtain an assessment from material experts regarding the product developed by the researcher. The results of this evaluation are then converted into percentages and adjusted to the criteria of feasible or not feasible. These criteria will be used to improve the quality of the product. Meanwhile, the results of the validation regarding the feasibility of the material can be seen in Table 7.

Table 7. Percentage data of student worksheets assessment results by material experts

Aspect	Expert Validator Score				Avera-ge Score	Total Average (%)	Criteria
	Lecturer		Teacher				
	Score	%	Score	%			
Material suitability	18	18/20 x 100% = 90%	19	19/20 x 100% = 95%	92,5 %	(92,5+ 87,49+ 85,93) /3 =87,96%	Valid and highly suitable.
Quality of presentation	24	24/28 x 100% = 85,71%	25	25/28 x 100% =89,28%	87,49 %		
Language suitability	27	27/32 x 100% =84,37%	29	29/32 x 100% =87,5%	85,93 %		

The average score data from the expert material validators, both lecturers and teachers, can be illustrated as shown in the diagram in Figure 3.

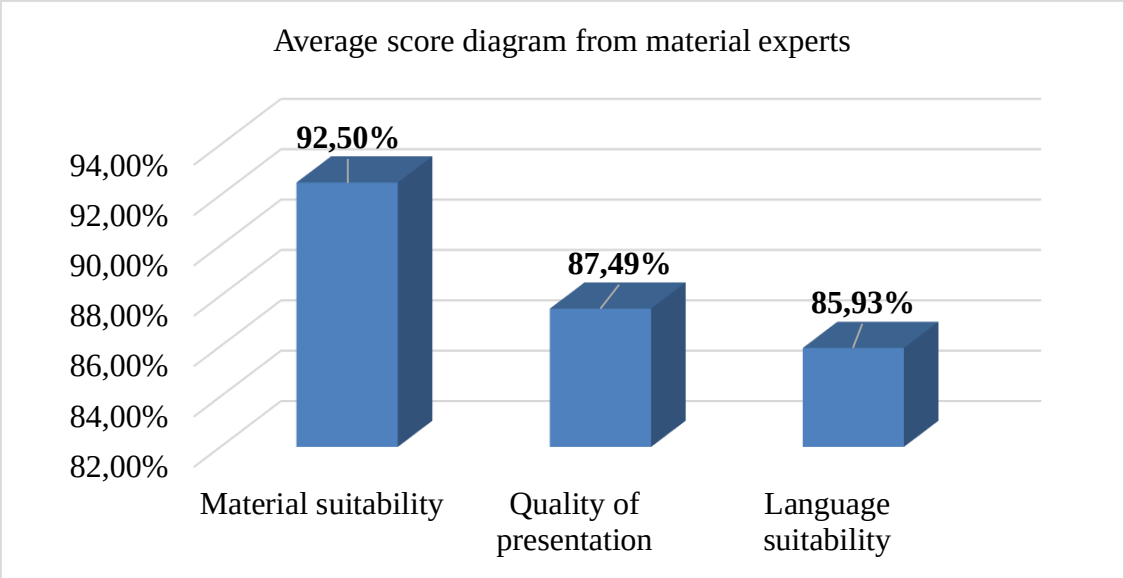


Figure 3. Assessment results by subject matter experts

Based on the assessment results from the material expert validators in Figure 3, it was found that the student worksheets developed by the researcher is declared valid and highly suitable for use without revision. The percentage of material suitability feasibility was 92.50%, presentation quality 87.49%, and language suitability 85.93%. From these data, the average percentage score from the material expert validators was 87,96%, falling under the criteria of valid and highly suitable for use. It can be concluded that the developed student worksheets has met the feasibility standards for use in chemistry learning for Class XI Senior High School and can proceed to the implementation stage.

Results of the Assessment by Media Experts

The validation of the student worksheets media aims to determine its validity and feasibility. The results of this assessment are then converted into percentages and adjusted to the criteria of feasible or not feasible for use in learning. Based on the validation of the student worksheets by expert validators, the average percentages obtained are as shown in Table 8.

Tabel 8. Data from the assessment by media experts

Aspect	Expert Validator Score		Total Average (%)	Categori
	Score	%		
Graphical suitability	54	54/60 x 100% = 90%	(90+85)/2= 87,5%	Valid and highly suitable.
Language suitability	17	17/20 x 100% = 85%		

The average score data from media expert validators can be depicted as a diagram in Figure 4.

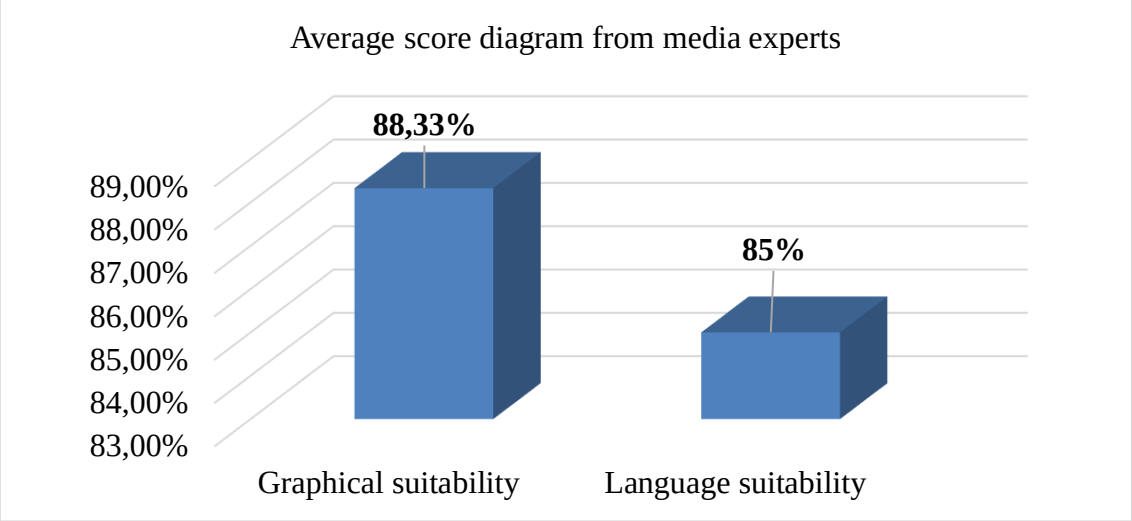


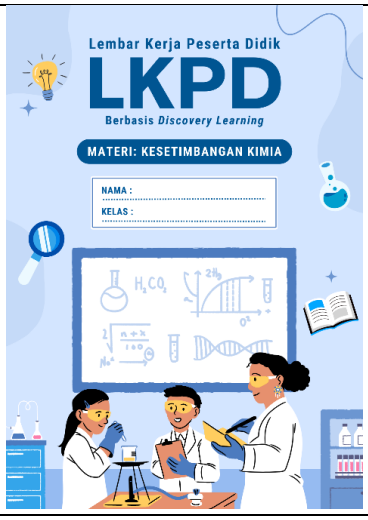
Figure 4. Assessment results by media experts

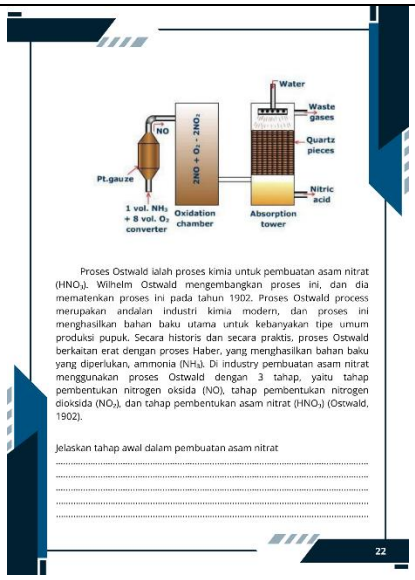
Based on the assessment results from the media experts in Figure 4, the student worksheets developed by the researcher is declared valid with some notes. The feasibility percentage for the graphical aspect reached 88.33%, and for the linguistic aspect, it was 85%. With an average percentage of 86.66%, this achievement score falls under the criteria of highly valid and highly suitable for use in learning. It can be concluded that the developed student worksheets has met the feasibility standards from the media aspect for use in chemistry learning for Class XI students at SMA Negeri 1 Galang and can proceed to the implementation stage with students.

Revisions by Media Experts

After the media expert lecturer provided an assessment, feedback and suggestions were obtained. The feedback and suggestions can be seen in Table 9.

Tabel 9. Results of revisions by media experts

Advice	Before revision	After revision
Cover Design (Adjust the cover illustration with the teaching material)		

Content design (Add image captions and sources)	 

After undergoing the validation and revision process, the developed student worksheets media product was obtained in a valid and standardized state according to BSNP (National Education Standards Agency) and is deemed suitable for use in learning.

IMPLEMENTATION

At this stage, after the student worksheets was declared valid by media and material experts, the implementation phase was carried out by testing the media on Class XI A students at SMA Negeri 1 Galang for the chemical equilibrium subject. The purpose of this trial was to evaluate the effectiveness of the student worksheets in improving students' Higher Order Thinking Skills.

Limited Group Trial on the Effectiveness of Student Worksheets in Improving Students' HOTS

The trial of the student worksheets (Student Worksheet) product on chemical equilibrium material was conducted at SMA Negeri 1 Galang, involving 35 Class XI students as samples. The participating students had diverse ability levels, namely high, medium, and low. This trial aimed to analyze the effectiveness of the discovery learning-based student worksheets developed by the researcher in improving students' HOTS. The effectiveness of the student worksheets was assessed based on the achievement of learning activities and individual mastery.

To measure the improvement in students' HOTS, pretest and posttest question sheets were used as instruments. The pretest sheet was administered to determine students' initial abilities and understanding before using the discovery learning-based student worksheets. Meanwhile, the posttest sheet was given to assess students' abilities and understanding after using the student worksheets.

The results of the data analysis on the use of the discovery learning-based student worksheets for chemical equilibrium material showed a significant improvement. The average pretest score was 21.142%, while the average posttest score reached 81.571%. Additionally, the N-Gain score was 0.77, categorized as high, indicating that the discovery learning-based student worksheets is highly effective in improving students'

HOTS. The pretest and posttest data of students' HOTS before and after using the student worksheets can be seen in Table 10.

Tabel 10. Student HOTS pretest and posttest data

No.	Data Type	Pretest Results	Posttest Results
1.	Highest Score	35	90
2.	Lowest Score	5	65
	Average	18,28	77,5

The pretest and posttest data of students' HOTS before and after the use of student worksheets were converted using the N-Gain formula. The statistical data of N-Gain scores related to students' HOTS on chemical equilibrium material are presented in Table 11.

Tabel 11. N-Gain score acquisition category

No.	N-Gain Index	Categori	Frequency	Percentage	Average	Criteria
1.	0,70≤**g**≤1,00	High	30	85,71%	0,77 or 77%	Very effective
2.	0,30≤**g**≤0,70	Medium	5	14,29%		
3.	0,00≤**g**≤0,30	Low	0	0		
	Total		35	100%		

Based on Table 11, it was found that 30 students, representing 85.71%, achieved an N-Gain score in the high category, while 5 students, representing 14.29%, achieved an N-Gain score in the medium category. Overall, the N-Gain score for students' HOTS on chemical equilibrium material was 0.77, categorized as high and deemed very effective. This indicates that the developed student worksheets significantly improved students' higher-order thinking skills. These results prove that the developed student worksheets can be an effective learning medium for enhancing students' HOTS in chemical equilibrium material.

This demonstrates that the discovery learning approach through the developed student worksheets encourages students to be more active in the learning process, enabling them to understand chemical equilibrium concepts more deeply. These findings align with previous research by Siahaan et al. (2022), whose study showed that the use of discovery learning-based student worksheets can increase students' motivation and learning outcomes. The research involved high school students and found that students who used discovery learning-based student worksheets showed significant improvement in their understanding of chemistry concepts compared to those who used conventional student worksheets. This opinion is also in line with research conducted by Nurjanah et al. (2020), which highlighted that discovery learning-based student worksheets not only enhances conceptual understanding but also improves collaboration among students. The study observed that students working in groups to complete discovery learning-based student worksheets were better able to discuss and share ideas, which in turn improved their understanding of the material. Meanwhile, Martaida et al. (2017) stated that students engaged in this learning approach not only understood chemical equilibrium concepts better but were also more capable of applying these concepts in real-life situations. The results of this study indicate that the discovery learning approach can enhance students' critical thinking skills.

Thus, the student worksheets developed in this study is suitable for broader use in chemistry education, particularly in chemical equilibrium material, to improve the quality of learning and students' HOTS.

EVALUATION

At this stage, the researcher distributed questionnaires to students to collect their responses regarding their satisfaction with the use of discovery learning-based student worksheets. These student responses serve as critical evaluation material, as they provide direct insights into the strengths and weaknesses of the developed learning media.

Student Responses to the Developed Student Worksheets

The results of respondents' satisfaction with the developed student worksheets are presented in Table 12.

Table 12. Student response to the developed student worksheets

NO.	STATEMENT	RESPOND																																			Total	%
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35		
1	I am interested in studying chemical equilibrium, especially learning using LKPD.	4	3	4	4	4	4	4	3	4	3	4	4	4	4	3	4	4	4	3	4	4	4	4	4	3	4	4	4	4	4	4	4	3	4	4	133	95%
2	The LKPD used can help my understanding in studying chemical equilibrium material.	4	4	3	4	4	3	4	4	4	4	4	4	3	4	4	4	4	4	4	4	3	3	4	3	4	4	4	4	3	3	3	4	4	4	4	131	93.57%
3	I am more motivated to learn using this LKPD.	4	3	3	4	3	4	4	4	4	4	4	4	3	4	4	3	4	4	4	4	4	3	4	3	4	4	4	4	3	4	3	4	4	4	4	131	93.57%
4	The instructions on this LKPD are clear.	3	3	3	4	4	6	4	4	4	4	3	4	3	4	4	4	4	4	4	3	3	3	4	3	4	4	4	4	3	3	3	4	4	3	4	129	92.14%
5	This LKPD encourages me to ask questions.	4	3	4	4	4	3	4	4	4	4	4	4	3	4	4	3	4	3	4	4	3	3	4	3	4	4	4	3	3	3	3	4	4	4	4	128	91.42%
6	This LKPD encourages me to collect data.	4	4	3	4	4	3	4	3	4	4	3	4	3	4	4	4	4	4	4	4	3	3	4	3	4	4	4	4	3	3	3	4	4	4	4	129	92.14%
7	LKPD ini mendorong saya untuk mengolah data.	4	4	3	4	4	4	4	4	4	4	4	4	3	4	4	4	4	3	4	3	3	4	3	4	4	4	4	3	3	3	4	4	4	4	4	131	93.57%
8	This LKPD encourages me to draw conclusions.	4	4	4	4	4	3	4	3	3	4	4	4	3	4	4	4	3	4	4	4	3	2	4	2	4	4	4	4	3	3	3	4	4	4	3	126	90.00%
9	The presentation of the material piqued my curiosity.	4	4	3	3	4	3	4	4	4	4	4	4	3	4	4	4	4	4	4	4	3	3	4	3	4	4	4	4	3	3	3	4	4	4	4	130	92.85%
10	The questions on the LKPD are easy to understand.	4	4	3	4	4	3	4	4	4	4	4	4	4	4	4	4	3	4	4	4	3	3	4	3	4	4	4	4	3	3	3	3	3	4	4	129	92.14%
AVERAGE PERCENTAGE																																						93%

Based on the data in Table 12. the percentage of respondents' satisfaction with the developed student worksheets obtained an average of 93%, including the criteria is very satisfied. The average data on the percentage of student satisfaction can be described as a diagram in Figure 5.

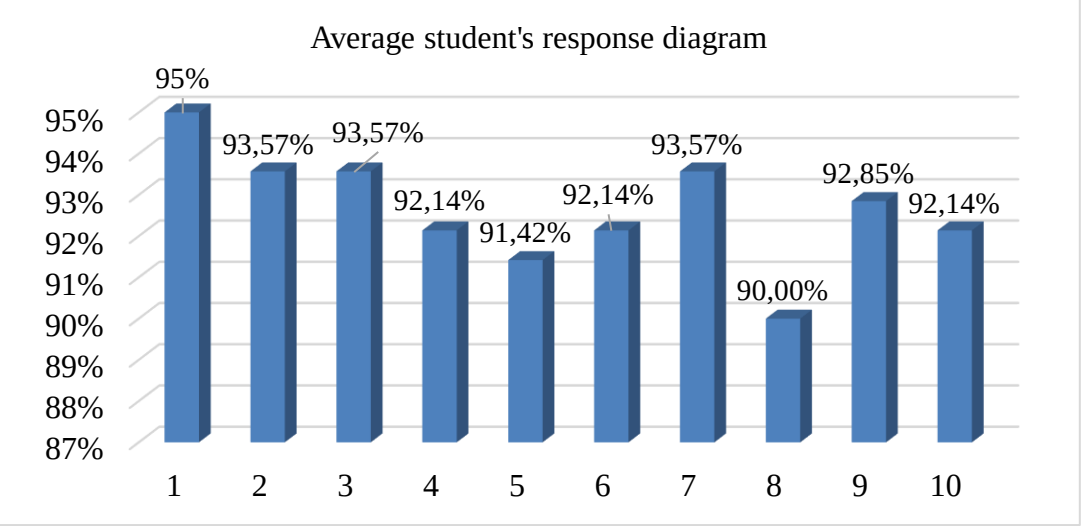


Figure 5. Assessment results by media experts

The evaluation results showed that the percentage of student satisfaction with the developed student worksheets reached an average of 93%. This figure is included in the very satisfied category, which indicates that the discovery learning-based student worksheets developed successfully meets the expectations and needs of students in the learning process. This high level of satisfaction reflects that the developed student worksheets is considered interesting, easy to understand, and effective in supporting student learning activities.

▪ CONCLUSION

Based on the results of the research and discussion that have been outlined, the following conclusions can be drawn: The developed discovery learning-based Student Worksheet is declared to meet the criteria of being highly valid according to BSNP (National Education Standards Agency) standards and is suitable for use in the learning process. The average validation scores from material experts were 88.64%, and from media experts, 86.66%. The discovery learning-based student worksheets has proven to be effective in enhancing students' Higher Order Thinking Skills on the topic of chemical equilibrium. This is evidenced by a significant increase in the average pretest score from 18.28% to 81.42% in the posttest. Additionally, the N-Gain score of 0.77 (77%) falls into the high category, indicating that the use of discovery learning-based student worksheets has a highly effective impact on improving students' higher-order thinking skills. The satisfaction level of student respondents towards the developed student worksheets was in the "very satisfied" category, with an average percentage of 93%.

▪ REFERENCES

Al-Nakhle, H. (2022). The effectiveness of scenario-based virtual laboratory simulations to improve learning outcomes and scientific report writing skills. *PLoS ONE, 17*(11 November), 1–13. https://doi.org/10.1371/journal.pone.0277359

Audina, C. R., & Syuhada, F. A. (2024). Development Of Science Literacy-Based Electronic Learner Worksheets (E-Lkpd) With The Context Of Batik Cloth Coloring On Chemical Bonding Material. *Jurnal Pendidikan dan Pembelajaran Kimia*, 13(2), 20-27. https://doi.org/10.23960/jppk.v13i2.29453

Auliyah, O., Hermansyah, & Safitri, A. (2024). LKPD Elastisitas dan Hukum Hooke Berbasis *Discovery learning* Untuk Meningkatkan Hasil Belajar Peserta Didik SMA. *Jurnal Literasi dan Pembelajaran Indonesi*a, 4(1), 4–7. https://jurnalfkip.samawa-university.ac.id/JLPI/article/view/1/43

Ariyana, Y., Pudjiastuti,A & Bestary, R. (2018). *Buku Pegangan Pembelajaran Berorientasi pada Keterampilan Berpikir Tingkat Tinggi*. Jakarta: Dikjen GTK Kementrian dan Kebudayaan.

Dwi, N. S., Hamid, A., & Leny. (2023). Pengembangan LKPD Scientific Critical Creative Thinking Untuk Meningkatkan Keterampilan HOTS Dan Berpikir Kreatif Peserta Didik Pada Materi Stoikometri. *Prosiding Seminar Nasional Kimia*, 2003(20), 73–80.

Ernawati. (2017). *Berpikir Tingkat Tinggi Atau Higher Order Thinking Skills (HOTS)*. Jakarta: ICICS.

Faizzah, N., & Sutarni, S. (2023). Investigasi kesulitan siswa dalam menyelesaikan masalah HOTS matematika. Jurnal Cendekia: *Jurnal Pendidikan Matematika*, 7(1), 1-10. https://doi.org/10.1234/jc.v7i1.1234

Fatayah, F. (2023). Penggunaan Laboratorium Virtual Dalam Proses Pembelajaran Kimia Untuk Meningkatkan Ketuntasan Belajar Siswa. *UNESA Journal of Chemical Education*, *12*(1), 23–29. https://doi.org/10.26740/ujced.v12n1.p23-29

Ichsan, J. R. (2022). LKPD Interaktif Berbasis HOTS. *Seminar Hasil Riset dan Pengabdian ke 4*, *April*, 868–874.

Indartiwi, A., Wulandari, J., & Novela, T. (2020). Peran Media Interaktif Dalam Pembelajaran Di Era Revolusi Industri 4.0. *KoPEN : Konfrensi Pendidikan Nasional* , 2(1), 28–31.

Julian, R., & Suparman. (2019). Analisis Kebutuhan E-LKPD Untuk Menstimulasi Kemampuan HOTS dalam Memecahkan Masalah. *Proceeding of the 1st Steeem*, 1(1), 238–243.

Cahyaningsih, E., & Karunia Assidik, G. (2021). Penerapan Model Pembelajaran Discovery Learning untuk Meningkatkan Minat Belajar pada Materi Teks Berita. *Buletin Pengembangan Perangkat Pembelajaran*, 3(1), 1–7. https://doi.org/10.23917/bppp.v3i1.19385

Mardianto, Y., Abdul Azis, L., & Amelia, R. (2022). Menganalisis Respon Siswa Terhadap Pembelajaran Materi Perbandingan Dan Skala Menggunakan Pendekatan Kontekstual. *Jurnal Pembelajaran Matematika Inovatif*, 5(5), 1313–1322. https://doi.org/10.22460/jpmi.v5i5.1313-1322

Martaida, T., Bukit, N., & Ginting, E. M. (2017). [2] Annisa, F. (2019, APRIL). PENANAMAN NILAI-NILAI PENDIDIKAN KARAKTER DISIPLIN PADA SISWASEKOLAH DASAR. *IOSR Journal of Research & Method in Education (IOSR-JRME)* e-ISSN: 2320–7388,p-ISSN: 2320–737X Volume 7, Issue 6 Ver. I (Nov. – Dec. 2017), PP 01-08 www.iosrjournals.org, 7(6), 1–8. https://doi.org/10.9790/7388-0706010108

Marwah, A. S., & Pertiwi, F. N. (2024). Literasi Sains Siswa dalam Berinovasi pada Pembelajaran IPA Berbasis Produk. *Jurnal Tadris IPA Indonesia*, *4*(1), 114–126. https://doi.org/10.21154/jtii.v4i1.3064

Meyanti, R., Bahari, Y., & Salim, I. (2019). Optimalisasi Minat Belajar Siswa Melalui Model Pembelajaran Problem Solving. *Proceedings International Conference on Teaching and Education (ICoTE)*, 2(2), 262. https://doi.org/10.26418/icote.v2i2.38239

Nurjanah, S., Rudibyani, R. B., & Sofya, E. (2020). Efektivitas LKPD Berbasis Discovery Learning untuk Meningkatkan Keterampilan Kolaborasi dan Penguasaan Konsep Peserta Didik Perkembangan sains dan teknologi abad 21 dengan pesat menimbulkan persaingan di kehidupan. *Jurnal Pendidikan dan Pembelajaran Kimia*, 9(1), 27–41. https://doi.org/10.23960/jppk.v9.i1.202003

Nurlian, Maysara, & Saefuddin. (2023). Pengembangan LKPD Mata Pelajaran Kimia Berbasis *Discovery learning* Pada Pokok Bahasan Termokimia Kelas XI. *Jurnal Pendidikan Kimia*, 8(3), 133–146. https://jpkim.uho.ac.id/index.php/journal/article/view/8

Nurmalasari, L., Akhbar, M. T., & Syaflin, S. L. (2022). Pengembangan Media Kartu Hewan Dan Tumbuhan (TUHETU) Pada Pembelajaran IPA Kelas IV SD Negeri. *Jurnal Riset Pendidikan Dasar*, 05, 1–8.

Oktavia, L., Saputri,D.F., & Sari,I.N. (2019).Pengembangan Lembar Kerja siswa (LKS) Berbasis Inkuiri Terbimbing Pada Materi Kalor Dan Perubahannya Di Kelas VII SMP Negeri 12 Pontianak. *Jurnal Pendidikan Sains dan Aplikasinya*. 2(1): 23-27

Purjiyanta Eka & Herni Budiati. (2019). *Panduan Praktikum Untuk SMP/MTs kelas VII.*

Jakarta: Erlangga.

Purwasi, L. A., & Fitiyana, N. (2020). Peningkatan Kemampuan Berpikir Tingkat Tinggi Siswa Melalui Pembelajaran Matematika Berbantuan LKPD Berbasis HOTS. *Jurnal Pendidikan Matematika (JUDIKA EDUCATION)*, 3(2), 65–74. https://doi.org/10.31539/judika.v3i2.1594

Putra, W. P., Gunamantha, I. M., & Sudiana, I. N. (2023). Pengembangan LKPD HOTS Dalam Meningkatkan HOTS Pada Pembelajaran Ipa SD. *International Journal of Educational Review*, 7(2), 169–180. https://doi.org/10.33369/ijer.v2i2.10967

Putrawangsa, S., & Hasanah, U. (2022). Analisis Capaian Siswa Indonesia Pada PISA dan Urgensi Kurikulum Berorientasi Literasi dan Numerasi Bagaimana trend capaian tersebut ? dan sejauh mana perubahan kurikulum selama ini berdampak pada. *jurnal Studi Pendidikan dan Pembelajaran*, *1*(1), 1–12.

Safitri, W., Hanifah, & Rusdi. (2020). Pengembangan Lembar Kerja Peserta Didik (LKPD) dengan Menggunakan Model Discovery Learning yang Terintegrasi Nilai-Nilai Islam pada Materi Lingkaran Di Kelas VIII SMP Negeri 12 Kota Bengkulu. *Jurnal Penelitian Pembelajaran Matematika Sekolah,* 4(JP2MS), 123–135. https://doi.org/10.33369/jp2ms.4.1.123-135

Said, F. F., Susanto, A., & Utami, N. P. (2023). Pengembangan Lembar Kerja Peserta Didik (LKPD) Berbantuan Canva yang Efektif. Jurnal Ilmiah Soulmath : *Jurnal Edukasi Pendidikan Matematika*, 11(1), 85–98. https://doi.org/10.25139/smj.v11i1.6020

Siahaan, M. Y., Sahputra, R., Sartika, R. P., Enawaty, E., & Rasmawan, R. (2022). Pengaruh Penggunaan LKPD Berbasis Discovery Learning terhadap Hasil Belajar Siswa pada Materi Konsep Mol. Edukatif : *Jurnal Ilmu Pendidikan*, 4(5), 6678–6689. https://doi.org/10.31004/edukatif.v4i5.3390

Sundayana, Rostina. (2014). S*tatistika Penelitian Pendidikan*. Bandung: Alfabeta.

Suryaningsih, S., & Nurlita, R. (2021). Pentingnya Lembar Kerja Peserta Didik Elektronik (E-LKPD) Inovatif dalam Proses Pembelajaran Abad 21. *Jurnal Pendidikan Indonesia*, 2(7), 1256–1268. https://doi.org/10.36418/japendi.v2i7.233

Syahputri, D. N., Solikhin, F., & Nurhamidah, N. (2023). Pengembangan e-LKPD Berbasis Discovery Learning untuk Meningkatkan Pemahaman Peserta Didik pada Materi Reaksi Redoks. *Jurnal Inovasi Pendidikan Kimia*, 17(1), 67–74. https://doi.org/10.15294/jipk.v17i1.37598

Syam, Y. R., & Kurniasih, S. (2023). Kebutuhan Terhadap Laboratorium Virtual Berbasis Masalah pada Materi Sistem Peredaran Darah. *Jurnal Imiah Pendidikan dan Pembelajaran*, 7(1), 166–172. https://doi.org/10.23887/jipp.v7i1.57970

Widoyoko, E. P. (2016). *Teknik Penyusunan Instrumen Penelitian*. Yogyakarta: Pustaka Pelajar.