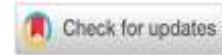




Development of multiple-representation based E-LKPD to improve students' scientific reasoning in classification of living things



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ABSTRACT

Scientific reasoning is a 21st-century skill that needs to be trained to prepare students to face the challenges of globalization. This can be supported by developing e-LKPD (electronic student worksheets) based on multiple representations. This research aims to determine the validity, practicality, and effectiveness of e-LKPD. This type of research is development research that applies the ADDIE model. The validation results by three experts had an average score of 81.66, 86.4, and 85.33 with a very valid category. Practical results were obtained based on student response questionnaires and observations of learning implementation. On a small scale at SMPN 2 Tanggul it was 78 (practical) and observation results were 87.11 (very practical), while on a class scale at SMPN 1 Wonosari, the student response questionnaire score was 81.28 (very practical) and observation results were 84.10 (very practical) practical), SMPN 1 Arjasa with a questionnaire response was 78.9 (practical) and observation results were 86.12 (very practical), MTsN 3 Banyuwangi was 87.72 (very practical) and observation results were 89.23 (very practical).

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INTRODUCTION

Education cannot be separated from a systematic learning process. Learning is a process of interaction between educators and students and learning resources that are applied in a learning environment (Abroto et al., 2021). Science learning is not just mastery of knowledge in the form of facts or concepts but is a process of discovery (Nupita, 2013). The science learning process

emphasizes direct experience for students to make it easier to understand the natural environment scientifically (Primayana et al., 2019). Science learning is concept learning that requires strong reasoning and mental processes in students. Students in Indonesia are relatively unable to apply scientific knowledge to face challenges in real life (Wisudawati & Sulistyowati, 2022).

Scientific reasoning is the ability to conclude based on existing evidence. Scientific reasoning is a cognitive skill in evaluating and understanding scientific information (Azmi et al., 2020). Scientific reasoning abilities compiled based on the Lawson Classroom Test of Scientific Reasoning (LCTSR) include six indicators including conservation reasoning, proportional reasoning, variable control, probability reasoning, correlational reasoning, and deductive hypothesis reasoning (Mandella et al., 2021). Students who have good scientific reasoning skills will easily understand conceptual material in learning (Azmi et al., 2020).

Scientific reasoning is one of the abilities tested in the Program for International Student Assessment (PISA) at the junior high school level according to the Organization for Economic Cooperation and Development (Schleicher, 2019). However, in Indonesia, students' scientific reasoning is still relatively low. Indonesia's science score is 396, very far below the international average science score of 489. Indonesia is ranked 70th out of 78 other participating countries (Wilujeng & Wibowo, 2021). Based on these data, there needs to be an improvement in the scientific reasoning of Indonesian students (Balqis et al., 2019). Scientific reasoning is very important to practice because it is the basis of the discovery process and builds skills such as problem-solving and higher-level thinking (Handayani et al., 2020). Scientific reasoning is a 21st-century skill that needs to be trained, it aims to prepare students to face the challenges of globalization (Khumaira, 2023).

LKPD is one of the learning media that can be developed by educators and designed according to the situation and conditions of the learning activities faced (Martine, 2020). LKPD contains student guides for carrying out activities and requires students to be more active in the learning process and competency development (Subakti et al., 2021). Therefore, the use of LKPD in the learning process can improve the expected implementation process. The LKPD that is often used in schools is not clear, has no color, and is not accompanied by pictorial representation. This makes students less interested and easily bored in using LKPD. Multiple-representation based LKPD can support understanding (Indah & Wahyuni, 2022).

Multiple-representation means re-representing the same concept in different forms and ways (Silaban et al., 2022). The forms and methods referred to are verbal, mathematical, pictorial, and graphic. There are three main functions of multiple representations, namely as a complement, overcoming obstacles to interpretation, and deepening understanding (Mahardika, 2012). There are several reasons why it is important to use multiple representations, including multi-intelligence, visualization for the brain, and helping construct representations (Dudeliyani et al., 2021). Multiple-representations can emphasize understanding of concepts because more than one representation is presented. This can be implemented using multi-representation based LKPD (Indah & Wahyuni, 2022).

Adapting to the rapid development of science and technological developments, the presentation of LKPD starts from sheets of paper and can then be operated on electronic devices (Dewi & Agustika, 2022). Electronic Student Worksheets (e-LKPD) can make it easier for teachers and students to carry out effective and efficient learning (Suryaningsih & Nurlita, 2021). The e-LKPD contains text, images, videos, or navigation that can be controlled by students which are not contained in conventional LKPD so that the e-LKPD can support the learning process with different learning styles and thinking speeds of students (Setiana & Nuryadi, 2021). The use of e-LKPD in science learning can be applied to material on the classification of living things and can help teachers strengthen students' understanding (Setyawati, 2023).

Classification material for living things has complex characteristics for each phylum and class, as well as many scientific names, making it difficult for students to understand (Kurniawan & Hasanah, 2022). This material is classified as material that is difficult to learn because students are required to understand the concept of classification of living things (Ratnawati et al., 2020). To overcome this, teachers can develop e-LKPD which helps students to develop their abilities in understanding concepts and gaining a broader understanding (Dewi & Agustika, 2022). Based on these problems, researchers want to know the validity of multiple-representation based e-LKPD to improve students' scientific reasoning on the material on the classification of living things.

This research offers novelty in the development of an e-LKPD based on multiple representations to enhance students' scientific reasoning skills in the topic of the classification of living organisms. Unlike previous studies, which generally focused only on the development of conventional LKPD or those based on a single type of representation, this research integrates various forms of representation (verbal, visual, table, and graphical) into an electronic platform. Previous studies, such as those conducted by Subakti et al., 2021, only developed LKPD in printed format or focused solely on visual representation. Additionally, this research also aims to improve students' scientific reasoning skills, which has not been the primary focus in many previous studies, particularly on the topic of the classification of living organisms. The multiple-representations based e-LKPD is not only intended to enhance conceptual understanding but also to improve students' scientific reasoning skills, which are crucial for science education. Therefore, the development of this multiple-representations based e-LKPD provides a new contribution to the field of digital learning media development, making it more interactive and integrated.

RESEARCH METHODS

Research Design

The type of research used in this research was development research. Development research is research that will obtain new products from certain products that have been developed. The new products obtained will be tested for their effectiveness in people's lives, thus the resulting products are expected to be useful both now and in the future (Sugiyono, 2009). This product development research applies the ADDIE model. is composed of five stages, namely Analysis, Design, Development, Implementation, and Evaluation. The research development design can be seen in Figure I.

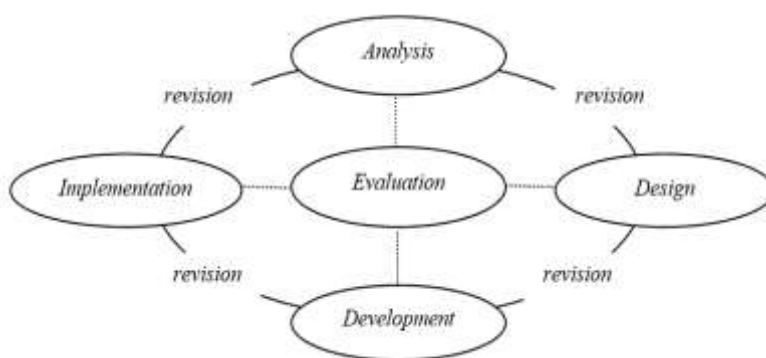


Figure I. Research Design for the Development of e-LKPD Based on Multirepresentation

Population and Samples

The subjects of the study were (1) two science lecturers and one biology education lecturer from the Faculty of Teacher Training and Education as validators (2) four science teachers from each school, namely SMPN 1 Tanggul, SMPN 1 Wonosari, SMPN 1 Arjasa, and MTsN 3 Banyuwangi (3) 9 students from SMPN 2 Tanggul, 32 students from SMPN 1 Wonosari, 31

students from SMPN 1 Arjasa, and 32 students from MTsN3 Banyuwangi. The object of the study was e-LKPD based on multi-representation of the material classification of living things.

Instruments

The instruments used in this research include validation, a student response questionnaire, and pre-test and post-test results. Validation was obtained based on the scores from expert lecturers, namely experts in content, media, and development, to determine the validity of the multiple-representations based e-LKPD. The student response questionnaire aims to collect data regarding the practicality of the multiple-representations based e-LKPD. The initial pre-test and post-test aim to determine the extent to which the e-LKPD can improve students' scientific reasoning skills. The tests used consist of 6 initial test questions and 6 final test questions according to the scientific reasoning indicators based on Lawson's Classroom Test of Scientific Reasoning (LCTSR). An explanation of scientific reasoning indicators is shown in Table I.

Table I. Indicators Scientific Reasoning

Scientific Reasoning Skill	Indicator
Conservational Reasoning	The ability to maintain an understanding or knowledge even when the appearance of an object changes.
Correlational Reasoning	The ability to think correlationally in determining whether two events or two variables are related or not.
Probabilistic Reasoning	The ability to think probabilistically as a situation where a specific answer is produced when repeated under the same conditions in different contexts.
Proportional Reasoning	The ability to provide answers based on the possible outcomes of an event.
Control of Variable	The ability to identify or control the variables of an existing problem.
Hypothetical-Deductive Reasoning	Hypothetical reasoning is the ability to test a hypothesis, while deductive reasoning is the ability to conclude. Therefore, hypothesis-deductive reasoning is the ability to conclude by first testing a hypothesis.



Based on the scientific reasoning indicators above, the following is an example of a grid of questions adapted to Lawson's Classroom Test of Scientific Reasoning (LCTSR). An example of the question grid can be seen in Table 2.

Procedures

Multi-representation based E-LKPD was developed using the ADDIE development model. The ADDIE development model includes 4 stages, namely Analysis, Design, Development, Implementation, and Evaluation. At the analysis stage, needs analysis and determination of materials to be developed in e-LKPD are carried out. Determination of materials is the initial step in development. The materials developed in this e-LKPD are the classification of living things. This design stage is the product design stage carried out to produce an initial product draft which includes a cover, foreword, table of contents, learning activities, and a bibliography. The development stage is the stage of assessing the feasibility of the product developed by material experts, media experts, and development experts. The purpose of validation is to obtain input and evaluation of the product that has been prepared for revision. The implementation stage is the stage for applying the e-LKPD product that has been prepared in real situations in the classroom so that the learning objectives that have been designed can be achieved. The evaluation stage is the final stage of the ADDIE model. This stage is to assess the quality of the product and the teaching

process. Determining evaluation criteria, selecting the right evaluation tools, and implementing evaluations are general procedures related to the evaluation stage.

Table 2. Grid of Questions

Reasoning Indicators	Question Indicators	Question	Cognitive Level	Answer
Conservational Reasoning	Students can analyze images of invertebrate animal groups	 <p>Analyze the image above. What group of animals does it belong to, and what characteristics indicate this?</p>	C4	<p>The image belongs to the group of invertebrate animals, with the following characteristics:</p> <ul style="list-style-type: none"> • The animal's body structure is made of an exoskeleton. • The excretory organs in lower invertebrates have not been found. • The nervous system of invertebrates is still simple. • Invertebrates reproduce generatively and/or vegetatively. • The circulatory system of invertebrates is open.
Corelational Reasoning	Students are able to relate the life cycle of invertebrate animals to an images	Draw the life cycle of a butterfly and explain the relationship between each phase!	C5	 <p>Egg: The female butterfly lays eggs on the surface of a leaf. Caterpillar: The egg hatches into a caterpillar, which eats actively and grows. Pupa: The caterpillar transforms into a pupa, where metamorphosis takes place inside. Butterfly: The chrysalis opens, and a butterfly emerges, ready to reproduce and begin the cycle again.</p>

Data Analysis

Based on the validity formula above, the following are the validation assessment criteria which can be seen in Table 3. The data analysis used is qualitative analysis and quantitative analysis. The data analysis used is validity analysis, practicality, and effectiveness. Determine the validity value with the following formula:

$$V = \frac{\text{Total Score}}{\text{Max score}} \times 100\%$$

Table 3. Validation Assessment Criteria (Octaviara & Pahlevi, 2019).

Score range	Category
81% - 100%	Very valid
61% - 80%	Valid
41% - 60%	Quite valid
21% - 40%	Less valid
0 – 20%	Not valid

Based on the practicality formula above, the following are the practicality criteria which can be seen in Table 4. In the practicality test measured in this research is the implementation of learning using observation sheets filled in by observers. Determine the practicality value using the following formula:

$$V = \frac{\text{Total Score}}{\text{Max score}} \times 100\%$$

Table 4. Practical Criteria for e-LKPD (Hidayat & Irawan, 2017).

Score range	Category
81% - 100%	Very practical
61% - 80%	Practical
41% - 60%	Quite practical
21% - 40%	Not practical
0 – 20%	Not practical

In testing the effectiveness of multiple-representation based e-LKPD to improve students' scientific reasoning, it can be seen from students' learning results in the cognitive domain in the form of pre-test and post-test scores. The purpose of measuring student learning outcomes is to determine the achievement of planned learning objectives. Measuring the effectiveness of students' cognitive learning outcomes can be measured based on Normalized gain (g) with the formula according to Hake (1998). The value scale used for Normalized gain (g) data will be categorized in Table 5.

$$V = \frac{\text{Posttest score} - \text{Pretest score}}{\text{Max score} - \text{Pretest score}}$$

Table 5. Criteria for Normalized gain (g) (Hake, 1998).

No.	Gain score(g)	Criteria
1	$g \geq 0.7$	Tall
2	$0.3 \leq g < 0.7$	Currently
3	$g < 0.3$	Low

RESULTS

This product development research applies the ADDIE model, which is composed of five stages, namely Analysis, Design, Development, Implementation, and Evaluation.

a. Analysis

Problem identification aims to find out problems that arise in the learning process. This activity is carried out by distributing questionnaires in the form of a Google form to students and teachers. Distributing this Google form to 20 science teachers and 185 students in several schools in East Java. The results of distributing the questionnaire in the form of a Google form to students and teachers can be seen in Table 6.



Table 6. Teacher Needs Analysis Questionnaire Results

Statement	Teacher's Answer	Percentage (%)
Obstacles to teaching science concepts in classroom learning	Students are less interested in learning science	61.5
	Difficult to apply abstract material	27
	Less than optimal in applying learning methods	11.5
Characteristics of LKPD applied in class	Paper-based LKPD	76.9
	e-LKPD	23.1
LKPD applied in learning can help students understand the material	Yes	30.8
	Not helpful	69.2
Teachers have designed e-LKPD based on multiple representations in the learning process	Yes	19.2
	Never	80.8
Student responses to material on the classification of living things in class	Students are confused because the material is abstract	42.3
	Students are less interested in the material on the classification of living things	42.3
	Students are happy with the material on the classification of living things	20.4

Based on Table 5, shows that the results of respondents from 20 junior high school science teachers in East Java experienced problems in teaching science concepts because students were less interested in learning science with a percentage of 61.5%, 27% had difficulty applying abstract material, and 11.5% lacked optimal in applying learning methods. Furthermore, 76.9% of the LKPD implemented in class are paper-based and 23.1% are in electronic form. 69.2% of the LKPD applied did not help students understand the material. 80.8% of teachers have never designed a multiple-representation based e-LKPD and only 19.2% of teachers have ever designed an e-LKPD. From the results of the questionnaire, students were confused and less interested in the material on the classification of living things with the same percentage, namely 42.3%, while 20.4% of students were happy with the material.

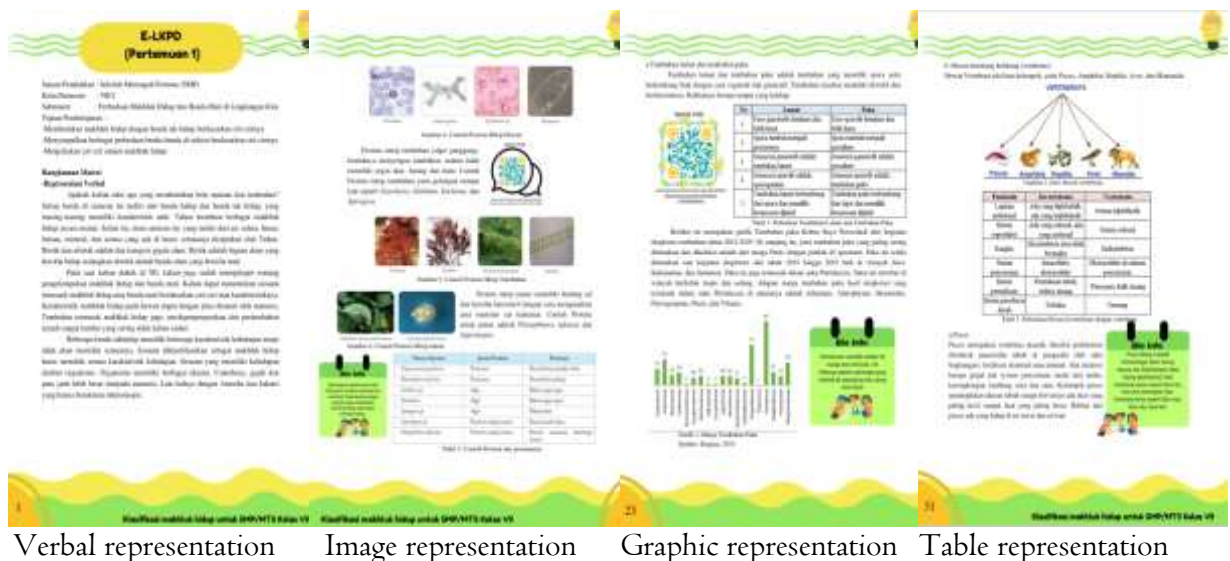


Figure 2. Multiple-representation based e-LKPD Design

b. Design

The design stage in this research was carried out through the preparation of a multiple-representation based e-LKPD on the material for the classification of living things, consisting of the preparation of the e-LKPD content framework, media selection, and preparation of tests. The results of the multiple-representation based e-LKPD design are presented in Figure 2.

c. Development

The expert validation test aims to obtain criticism, suggestions, input, and assessment of the multiple-representation based e-LKPD draft that has been prepared. Implementation of validation activities includes validation of e-LKPD and validation of learning tools. Validation activities were carried out by three expert validators and four users.

Multiple-representation based E-LKPD Validation Results

The multiple-representation based e-LKPD validation assessment was carried out by three expert validators, namely science education and biology education lecturers (material, media and development experts). This validation activity aims to measure the validity of the e-LKPD developed before the field trial process is carried out. Data from validation results by expert validators can be seen in Table 7.

Table 7. Multiple-representation based e-LKPD validation data

Evaluation	Score						
	Expert Validator	Material	Criteria	Media	Criteria	Development	Criteria
Validator 1	83.33	Very Valid	86.4	Very Valid	82	Very Valid	Very Valid
Validator 2	73.33	Valid	84	Very Valid	85	Very Valid	Very Valid
Validator 3	88.33	Very Valid	88.8	Very Valid	89	Very Valid	Very Valid
Average	81.66	Very Valid	86.4	Very Valid	85.33	Very Valid	Very Valid

Based on Table 7, it can be seen that the average obtained from the three validators' assessment results was 81.6 in the material assessment with very valid criteria, 86.4 in the media assessment with very valid criteria, and the development assessment was 85.33 in the very valid category. This shows that the multiple-representation based e-LKPD has been declared valid in terms of material, media and development and can be continued at the validation stage by users. Validation of multiple-representation based e-LKPD by users was carried out on four users, namely class VII science teachers from the school which was carried out as a research site. Data from validation results by users can be seen in Table 8.

Table 8. User Validation Results Data

Validator	Score	Criteria
User 1	90.4	Very Valid
User 2	83.2	Very Valid
User 3	86.4	Very Valid
User 4	90.4	Very Valid
Average	87.6	Very Valid

Based on Table 8, it can be seen that the validation results by users show an average multiple-representation based e-LKPD score were 87.6 with very valid criteria. The results of this validation indicate that the multiple-representation based e-LKPD has been declared valid and can be tested on a small-scale trial to determine its practicality and effectiveness. The small-scale trial in

class VII C of SMPN 2 Tanggul consisted of 9 students with details of 3 students with high cognitive abilities, 3 students with medium cognitive abilities, and 3 students with low cognitive abilities. The results of small-scale trials are described below.

Student Response Questionnaire Results

Measuring the practicality of multiple-representation based e-LKPD is determined by the results of student response questionnaires. This response questionnaire aims to determine students' responses after reading and studying the e-LKPD. Student response questionnaires were given to 9 students of class VII C SMPN 2 Tanggul. The results of the student response questionnaire in the small-scale trial can be seen in Table 9.

Table 9. Results of Student Response Questionnaires on Small-Scale Trials

Trials	Average Questionnaire Results	Criteria
Small Scale (VII C)	78	Practical

Based on Table 9, it can be seen that the average student response questionnaire score for multiple-representation based e-LKPD on the overall classification of living things is 78 with practical criteria. This shows that students responded well to the multiple-representation based e-LKPD that had been developed.

Student Pre-test and Post-test Results

The assessment of students' scientific reasoning abilities was obtained from the results of the average pre-test and post-test scores carried out in four meetings in class VII C at SMPN 2 Tanggul. Data from the pre-test and post-test scores on students' scientific reasoning abilities can be seen in Figure 3.

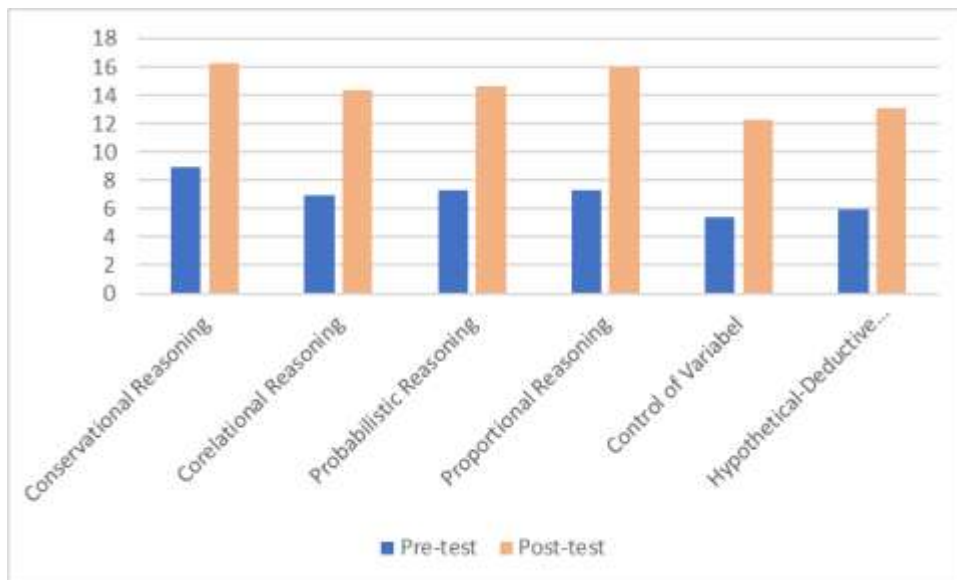


Figure 3. Average Small-Scale Scientific Reasoning Score

Based on Figure 3, it can be seen that the scores of 9 students in small-scale trials in class VII C of SMPN 2 Tanggul during four meetings with conservation reasoning mean pre-test was 8.97 and post-test was 16.25. The second indicator is correlation reasoning with a pre-test was 6.94 and a post-test was 14.36. The third indicator is probabilistic reasoning which has a pre-test value was 7.28 and a post-test of 14.61. The fourth indicator is proportional reasoning with a pre-test of 7.33 and a post-test of 16. The fifth indicator is variable control with a pre-test value was

5.42 and a post-test was 12.25. The sixth indicator is deductive hypothesis reasoning with a pre-test score was 5.95 and post-test 13.11. The mean of each indicator in the pre-test value is 6.98 and the post-test value is 14.43. The results of N-Gain in the four meetings that have been held can be seen in Figure 4.

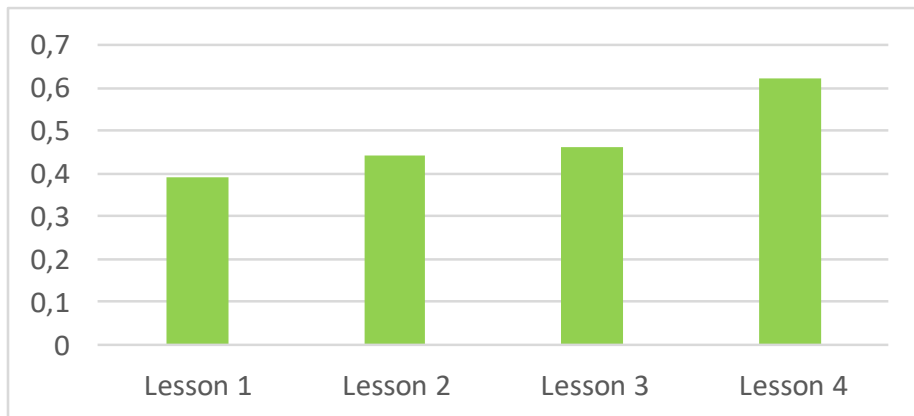


Figure 4. N-Gain Results of Small-Scale Trials

Based on Figure 5, it shows that there has been an increase in the average score at each meeting. The Normalized Gain (N-Gain) measurements carried out showed that at meeting one the N-Gain score was 0.39 with medium criteria. At meeting two it showed an increase to 0.44 with moderate criteria. Meeting three with N-Gain 0.46 and meeting four with 0.62 have medium criteria. This shows that multiple-representation based e-LKPD is effective in improving students' scientific reasoning abilities so that it can be continued in class-scale trials.

Learning Implementation Observation Results

Learning implementation observation sheets were given to three observers whose aim was to observe learning implementation while using multiple-representation based e-LKPD. The results of observations of learning implementation in small-scale trials can be seen in Table 10.

Table 10. Observation Results of Learning Implementation in Small-Scale Trials

Meeting	Observer Value (%)			Average Value	Criteria
	Observer 1	Observer 2	Observer 3		
1	66.20	66.20	70.77	67.69	Practical
2	70.76	80.7	81.53	77.66	Practical
3	80	81.53	83.07	81.5	Very Practical
4	87.6	87.6	86.20	87.11	Very Practical

Based on Table 8, it can be seen that the implementation of learning using multiple-representation based e-LKPD at meetings one and two obtained practical results, namely with an average of 67.69, and 77.66. At meetings 3 and 4 the average was 81.5 and 87.11 with very practical criteria. The improved e-LKPD will then enter the Implementation stage and will be tested on a class scale to measure the practicality and effectiveness of multiple-representation based e-LKPD.

d. Implementation

This multiple-representation based e-LKPD implementation stage was carried out in three schools, namely SMPN 1 Wonosari, SMPN 1 Arjasa, and MTsN 3 Banyuwangi during four meetings on the material of classification of living things.

Student Response Questionnaire Results

Giving student response questionnaires aims to determine the practicality of multi-representation-based e-LKPD. Filling out the student response questionnaire is done via Google Form. The results of the student response questionnaire regarding the use of multi-representation-based e-LKPD are in Table II.

Table II. Results of Student Response Questionnaire on Class Scale Trial

School	Average Questionnaire Results	Criteria
SMPN I Wonosari	81.28	Very Practical
SMPN I Arjasa	78.9	Practical
MTsN 3 Banyuwangi	87.72	Very Practical

Based on Table II, it can be seen that the average score of the student response questionnaire to multiple-representation based e-LKPD on the material of classification of living things at SMPN I Wonosari with 32 students is 81.28 with very practical criteria, SMPN I Arjasa with 31 students and the results of the research a score of 78.9 has practical criteria, and MTsN 3 Banyuwangi with 32 students has an average questionnaire response result of 87.72 with very practical criteria. These results show that students gave a positive response to e-LKPD based on multiple representations of material on the classification of living things.

Student Pre-test and Post-test Results

The assessment of students' scientific reasoning abilities was obtained from the results of the average pre-test and post-test scores conducted four times in class VII A of SMPN I Wonosari with 32 students, class VII F of SMPN I Arjasa with 31 students, and in-class VII E MTsN 3 Banyuwangi as many as 32 students. The results of the pre-test and post-test scores based on indicators of students' scientific reasoning abilities carried out four times can be seen in Table 12.

Table 12. Class Scale Trial Results

No.	Scientific Indicators	Reasoning	Average					
			SMPN I Wonosari		SMPN I Arjasa		MTsN 3 Banyuwangi	
			Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
1.	Conservation Reasoning		5.64	15.59	6.2	16.27	5.48	18.14
2.	Correlational Reasoning		4.39	12.7	6.71	15.55	5.87	17.88
3.	Probabilistic Reasoning		4.37	13.94	6.01	15.67	5.07	18.01
4.	Proportional Reasoning		6.13	15.93	6.1	11.84	5.27	18.68
5.	Variable Control		4.85	14.71	5.59	15.67	4.76	18.32
6.	Deductive Reasoning	Hypothetical	4.86	12.99	5.16	13.89	4.37	18.02
Average			5.04	14.31	5.96	14.82	5.14	18.18

Based on Table 12, it can be seen that students' scientific reasoning scores are known through the average pre-test and post-test scores of three schools, namely SMPN I Wonosari, SMPN I Arjasa, and MTsN 3 Banyuwangi. At SMPN I Wonosari with a pre-test score of 5.04 and a post-test score of 14.31. The second school, namely SMPN I Arjasa, has an average pre-test score of 5.96 and a post-test score of 14.82. The third school is MTsN 3 Banyuwangi with an average pre-test score of 5.14 and a post-test score of 18.18. The N-Gain results in four meetings at the three schools can be seen in Table 13.



Table 13. N-Gain Class Scale Trial Results

Meeting	SMPN I Wonosari		SMPN I Arjasa		MTsN 3 Banyuwangi	
	N-Gain	Criteria	N-Gain	Criteria	N-Gain	Criteria
1	0.43	Currently	0.49	Currently	0.61	Currently
2	0.47	Currently	0.52	Currently	0.7	Currently
3	0.51	Currently	0.54	Currently	0.72	Tall
4	0.55	Currently	0.6	Currently	0.74	Tall
Average	0.49	Currently	0.54	Currently	0.69	Currently

Based on Table 13, it shows that there was an increase in the average score at each meeting at SMPN I Wonosari, SMPN I Arjasa, and MTsN 3 Banyuwangi. The N-Gain results at SMPN I Wonosari from meetings one to four were respectively 0.43, 0.47, 0.51 and 0.55. The average N-Gain from the four meetings was 0.49 with medium criteria. The second school, namely SMPN I Arjasa, had N-Gain results from meetings one to four consecutively, namely 0.49, 0.52, 0.54 and 0.6. The average N-Gain result for the four meetings was 0.54 with medium criteria. The next school is MTsN 3 Banyuwangi with the N-Gain values for meetings one to four respectively being 0.61, 0.7, 0.72, and 0.74. The average of the N-Gain value is 0.69 with medium criteria. These results show that based of multiple-representation e-LKPD is effective in improving students' scientific reasoning abilities as seen through the results of the pre-test and post-test.

Learning Implementation Observation Results

Learning implementation observation sheets were given to three observers whose aim was to observe learning implementation while using multi-representation-based e-LKPD during four meetings at SMPN I Wonosari, SMPN I Arjasa, and MTsN 3 Banyuwangi. The results of observations of learning implementation in class scale trials can be seen in Table 14.

Table 14. Observation Results of Learning Implementation in Class Scale Trials

Meeting	SMPN I Wonosari		SMPN I Arjasa		MTsN 3 Banyuwangi	
	Average Value	Criteria	Average Value	Criteria	Average Value	Criteria
1	72.81	Practical	78.76	Practical	81.53	Very Practical
2	76.41	Practical	81.53	Very Practical	83.58	Very Practical
3	81.53	Very Practical	83.07	Very Practical	86.66	Very Practical
4	84.10	Very Practical	86.12	Very Practical	89.23	Very Practical

Based on Table 14, it can be seen that the average observation value of learning implementation from the first meeting to the fourth meeting has practical and very practical criteria.

e. Evaluation

The evaluation stage aims to determine whether the e-LKPD based on multi-representation material on the classification of living things for the learning process can be said to be valid, practical, and effective. This evaluation stage does not occur at all stages, but only at the development and implementation stages. Based on the previous stage, it can be seen that the multiple-representation based e-LKPD is considered very valid by expert validators and users. In the small-scale trial, there was an increase in the N-Gain results and the results of observations of learning implementation from meeting one to meeting four as well as the results of the average student response questionnaire in the valid category. In the class scale trial, the category was valid for SMPN I Arjasa and very valid for SMPN I Wonosari and MTsN 3 Banyuwangi.

DISCUSSION

The discussion of the results of this research includes the development of multi-representation-based e-LKPD that is valid, practical, and effective. Validity testing is a step taken to test the content. The purpose of the validity test is to measure the accuracy of the substance to be used in research (Hakim et al., 2021). Practicality is obtained based on the implementation of learning (Choirullita et al., 2020). Effectiveness refers to the results achieved in the form of pre-test and post-test (Arif & Eby, 2020).

a. Valid Multiple-Representation based E-LKPD

Validity is a measure that can show the level of reliability or validity of a product which stimulates several aspects of assessment (Mirnawati et al., 2022). Validity is carried out by experts by considering aspects of content, language, presentation and graphics. Validation is said to be complete if the validator states that a product is valid, so a trial can be carried out. The products developed are adjusted to input from validators (Sari et al., 2022). Validation was carried out by three expert validators, namely material experts, media experts, and development experts (Monica et al., 2021).

Validity results were obtained from expert and user assessments before multi-representation-based e-LKPD on living creature classification material was used in learning on a small scale and class scale. If the product being developed is said to be very valid and suitable for use, it can proceed to practical testing (Ani & Lazulva, 2020). The validator assessment is not only on the e-LKPD being developed but also on the learning support instruments or devices on the multi-representation based e-LKPD that will be used. Validated learning tools include teaching modules and pre-test and post-test questions. Liiman et al. (2022) explained that the pre-test was carried out before learning to determine students' initial abilities and the post-test was carried out to determine abilities after learning. Overall, the multi-representation-based e-LKPD validation on living creature classification material is considered valid so it can be carried out to the next stage. This is to the theory of that Angriani et al. (2020) that the learning media is included in the valid category or suitable for use at the next stage, namely small-scale use trials.

b. Practical Multiple-representation

The practicality of e-LKPD based on multiple representations of the classification of living things is determined based on the results of student responses and observations of learning implementation. Student response questionnaires are used to determine student responses to the use of the learning media developed (Kartini & Putra, 2020). The student response questionnaire was obtained via Google Forms. Apart from the student response questionnaire, to find out the practicality of multiple-representation based e-LKPD through observations of learning implementation. Mahfudin et al. (2020) state that in the learning process observations or assessments are carried out by observers through learning implementation sheets.

The practicality of multiple-representation-based e-LKPD is also supported by observations of learning implementation during teaching and learning activities. The purpose of this observation is to determine the implementation of learning using multi-representation based e-LKPD. Observations of learning implementation are carried out by observers at the same time as the learning process is taking place (Murwanto et al., 2022). The main function of implementation observation is to observe and evaluate the extent to which learning activities are implemented using products that have been developed (Wijaya & Cahyaka, 2023). The implementation of the learning process can be analyzed through observation sheets. The observation sheet is filled in by the observer to assess teacher activities and student activities during the learning process (Maulida et

al., 2021). Based on the description above, e-LKPD based on multiple representations of the classification of living things is said to be practical for use in learning.

c. Effective multiple representation

The effectiveness of e-LKPD based on multiple-representations on the classification of living things in this research to improve students' scientific reasoning was analyzed through pre-test and post-test scores. The pre-test is given before learning and the post-test is given at the end of each lesson. Product effectiveness can be assessed based on student learning outcomes (Kholifahtus et al., 2021). The effectiveness of multi-representation-based e-LKPD was measured during small-scale trials and class-scale trials.

A small-scale trial was carried out by 9 students of class VII C SMPN 2 Tanggul in four meetings. At each meeting, a pre-test and post-test are carried out which refer to Lawson's Classroom Test of Scientific Reasoning (LCTSR). The results of this description can be seen in Graph I. Based on Graph I, it can be seen that there has been an increase in the average student scientific reasoning score for each indicator. These indicators consist of conservation reasoning, correlation reasoning, probabilistic reasoning, proportional reasoning, variable control, and deductive hypothesis reasoning. The results of the increase in the average score of students' scientific reasoning in conservation reasoning were 16.25, correlation reasoning 14.36, probabilistic reasoning with a mean of 14.61, proportional reasoning with a mean of 16, controlling variables with a mean of 12.25 and deductive hypothesis reasoning with a mean of 13.11.

The next effectiveness test is on the class scale which lists the pre-test and post-test scores based on Lawson's Classroom Test of Scientific Reasoning (LCTSR) indicators. Class scale trials were carried out at three schools including SMPN 1 Wonosari, SMPN 1 Arjasa, and MTsN 3 Banyuwangi. Based on this table, there was an increase due to the e-LKPD presented consisting of several representations, including verbal representations, images, graphs, and tables. This is to the theory of Anggraini et al. (2022) that based on multi-representation LKPD can improve students' cognitive abilities. This can also help students understand concepts and master problem-solving techniques. Multiple-representation-based LKPD has three main objectives, namely completing students' cognitive phase, reducing the possibility of additional interpretation errors, and fostering deeper mastery of concepts (Putri et al., 2020). Multiple representation has three main functions, namely as a complement, interpretation, and building understanding (Mahardika & Wicaksono, 2023).

CONCLUSION

The multiple-representation based E-LKPD on living creature classification material is included in the very valid criteria based on the average validation results by three expert validators and users. The validation results by the validator on the material aspect were 81.66 (very valid), the media aspect 86.4 (very valid), and the development aspect 85.33 (very valid). For expert users with an average of 87.6 (very valid). Multiple-representation based E-LKPD on the classification of living things is included in very practical criteria based on the results of student response questionnaires and the results of observations of learning implementation. In the small scale trial, the results of the student response questionnaire were 78 (practical) and the results of observing the implementation of learning were 87.11 (very practical), while in the class scale trial the student response questionnaire score of SMPN 1 Wonosari was 81.28 (very practical) and the observation results implementation of learning 84.10 (very practical), SMPN 1 Arjasa student response questionnaire score 78.9 (practical) and observation results of learning implementation 86.12 (very practical), and MTsN 3 Banyuwangi student response questionnaire score 87.72 (very practical) and observation results of learning implementation 89.23 (very practical). E-LKPD based on multiple representations of the classification of living things can improve students' scientific



reasoning abilities obtained from increasing the N-Gain score at each meeting. In small-scale trials, the average value *N-Gain* score was 0.48 (medium), while in the class scale trial of SMPN 1 Wonosari it was 0.49 (medium), SMPN 1 Arjasa 0.54 (medium), and MTsN 3 Banyuwangi 0.69 (medium). This is based on multiple representations e-LKPD can be used as a benchmark or reference for conducting further research on different materials and adding other representations besides verbal representations, pictures, graphs, and tables.

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