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Innovation in the Development of E-LKPD Oeriented on Project Based Learning (Pjbl) Integrated with Steam in the Subject of Biology

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Abstract: This study aims to produce a teaching material product in the form of e-LKPD oriented Project Based Learning integrated with STEAM in Biology Subject for Phase E SMA/MA Students which is valid, practical and effective. The subjects of the study were biology teachers and students of class X 5 SMAN 18 Makassar. This type of research is research and development (R&D) which adapts the ADDIE development model which has five stages, namely analysis, design, development, implementation, and evaluation. Validity data were collected through a product validation questionnaire on environmental change material. Practicality data were collected through student and teacher response questionnaires, and effectiveness data were collected through cognitive learning outcome tests. The data obtained were analyzed using descriptive statistical analysis. The results showed that the average value of the total validity and product development was in the very high validity category (1). The response results meet the criteria of practicality because the average student response to product development is in the very practical category (85.22%) and the average teacher response value to product development is in the very practical category (93.31%). Product development meets the criteria of effectiveness because the average N-gain value of each student is in the moderate category (0.7).

Keywords: Cognitive learning outcomes; Electronic Student Worksheets (LKPD); Project Based Learning; STEAM.

Introduction

Education is a process of learning, knowledge, skills and habits of a person that are inherited through teaching, training, or research. The 21st century has indeed brought fundamental changes in various aspects of life, including economics, social, education, and industry. In this century, we see knowledge-oriented education as the foundation for preparing the younger generation to face unprecedented challenges, with jobs, technologies, and problems that are still in the process of creation or discovery (Muhali, 2019).

The goal of 21st century education is to encourage students to master skills that are important and useful for them to be more responsive to changes and developments in the era. The most important thing in 21st century education is to encourage students to have a deep knowledge base and understanding to become lifelong learners. The education system needs to consider a number of aspects that are domains in education, one of which is "Digital-Age Literacy" (Junanto & Afriani, 2016).

The function and purpose of education in Indonesia have been regulated in Law No. 20 of 2003 concerning the national education system which makes everything related to the implementation of national education in Indonesia which includes the definition of education, the function and purpose of education, types of

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education, levels of education, education standards and so on (Wayan, 2019). The learning process is an activity carried out by two parties, namely teachers as facilitators and students as learning that involves intermediaries to convey messages in the form of knowledge (cognitive), skills (psychomotor), and attitudes and positive values (affective). In conveying the message, an intermediary is needed so that the value and transfer of knowledge can be achieved precisely on target. These intermediaries are media and learning resources that greatly support and influence learning success.

Learning, both in class and outside the classroom, is a continuous process that aims to develop students' abilities, helping them change from not understanding to mastering the material. During learning, students gain knowledge and experience through interaction with the teacher, who acts as a transmitter of information, while students become recipients. Anything that can be used by teachers and students to support the teaching and learning process, either separately or in combination, with the aim of increasing the effectiveness and efficiency of learning objectives is known as learning resources (Aliah, 2024).

Technological advances have driven the need for digital design-oriented LKPD innovations, which make it easy for students to access learning materials anytime and anywhere. With the existence of learning media in the form of digital LKPD, students can learn independently more easily, making the learning process more flexible and not limited to the presence of teachers in the classroom. The use of this digital LKPD also supports a shift in learning, from being initially teacher-centered to being more focused on students, allowing them to have greater control in the learning process (Ubaidillah, 2016).

According to Electronic Student Worksheets are a series of activities used by students in conducting investigations and solving problems, (Putriyana et al., 2020). (Umriani et al., 2020)explain that E-LKPD is a student work guide to make it easier for students to understand learning materials in electronic form whose application uses desktop computers, notebooks, smartphones, or cellphones. A set of basic activities that must be carried out by students to maximize understanding in an effort to achieve learning goals (Puspita et al., 2021).

Project Based Learning (PjBL) is a learning model recommended in the independent curriculum, while Science, Technology, Engineering, Art, and Mathematics (STEAM) is more of a learning strategy. PjBL learning has its own steps, different from the steps of STEAM-oriented PjBL (hereinafter the term PjBL-STEAM is used). The characteristics of PjBL and PjBL STEAM are similar, but PjBL STEAM emphasizes the design process. The design process is a systematic approach to developing solutions to problems with well-defined outcomes (Morgan, 2013).

STEAM-integrated PjBL-oriented LKPD is an innovative learning that combines student worksheets, problem-oriented projects, and integration of various disciplines such as science, technology, engineering, art, and mathematics. The goal is to provide a more meaningful learning experience for students by actively involving them in completing real projects that are relevant to everyday life. Through this approach, it is hoped that students can develop critical, creative, and collaborative thinking skills, as well as understand the relationship between various fields of science.

One of the materials in the Biology subject of Senior High School Phase E according to the independent curriculum discusses innovation in biological technology and environmental change. This material is studied in the learning outcomes (CP), namely at the end of phase E, students have the ability to create solutions to problems based on local, national, or global issues related to understanding the diversity of living things and their roles, viruses and their roles, innovation in biological technology, ecosystem components and interactions between components and environmental change. Mastery of the material as a whole and with various learning resources. Teachers play a greater role as facilitators, and one of the teacher's tasks is to provide learning tools that are appropriate to their needs. Based on the explanation given by Sari et al., it is clear that the importance of LKPD for students is as a tool to build their knowledge, where LKPD will later be prepared by teachers (Rahman R S, 2020).

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Based on the results of initial observations at SMAN 18 Makassar City, LKPD is very necessary in biology learning. LKPD used in the school is in the form of sheets containing theories and many theoretical questions that can be answered by students by looking at books or literature from the internet. In addition, the LKPD used has a less attractive design, the explanations and theories presented do not explain clearly, and the activities in it do not guide students to make observations so that students are less active in learning, so E-LKPD is needed in student learning by implementing the STEAM integrated PjBL model.

Other problems in biology learning in class X 5 SMAN 18 Makassar include low student learning participation. Many students lack focus and do other activities during the lesson. Based on interviews, it is known that their attitudes towards biology tend to be negative, with some feeling lazy or less interested in following the lesson. The learning methods applied mostly use lectures, which prioritize memorization and do not involve students in interactive activities. As a result, student learning outcomes are low, so that the learning objectives set by the curriculum have not been achieved optimally. The current curriculum emphasizes in-depth learning experiences, and demands good learning outcomes from students.

The implementation of STEAM-PjBL into learning encourages teachers to be able to innovate in managing learning so that students can increase their learning motivation, provide meaningful learning, and provide opportunities for students to develop their scientific literacy (Aguilera & Ortiz-Revilla, 2021). Based on the background above, a research was conducted on the development of E-LKPD entitled "Development of E-LKPD Oriented to Integrated STEAM PjBL for Phase E Students".

This study aims to develop an electronic student worksheet (E-LKPD) oriented toward the Project-Based Learning (PjBL) model integrated with the STEAM approach in the subject of biology. The development is intended to produce an innovative, interactive, and contextually relevant digital learning tool that enhances student engagement in the learning process. Additionally, the study seeks to examine the validity, practicality, and effectiveness of the E-LKPD in improving student learning outcomes through the integration of science, technology, engineering, arts, and mathematics within meaningful project-based activities.

Method

The type of research that will be used is research and development or (R & D) Research and Development. This development research refers to the ADDIE model (analysis, design, development, and implementation, and evaluation). The main product developed is E-LKPD.

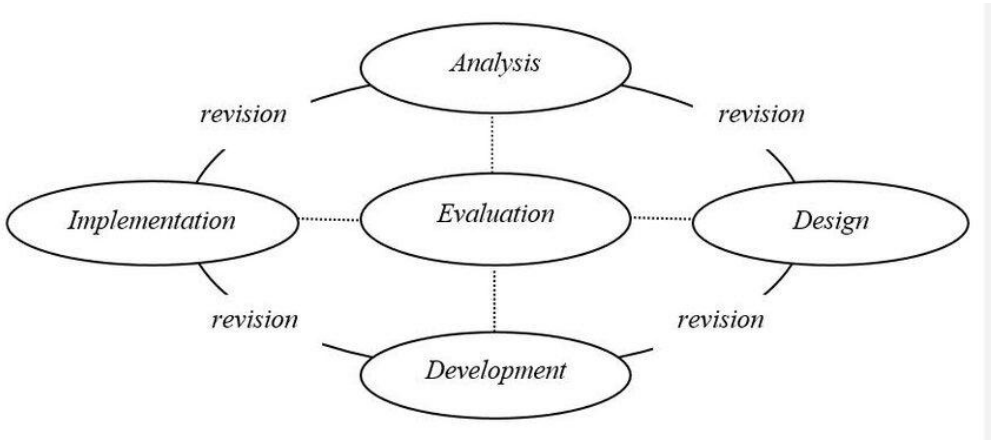

Figure 1. The ADDIE Concept

Analysis

At this stage, the researcher conducts initial data collection activities to find a problem in learning that occurs in schools. The analysis stage is carried out by analyzing student needs, analyzing learning outcomes, and analyzing objectives. Analysis of student needs was carried out at SMAN 18 Makassar City by observing the school where the research will be conducted, such as observing teachers teaching in class, or observing teaching materials and learning media used. The aspects obtained at this analysis stage, teachers teach in class using more lecture methods, teaching materials used in the form of printed books, LKPD sheets, and media in the form of Power Point (PPT). The data collected aims to determine the needs of students related to.

Analysis of learning outcomes is carried out through a review of the material used in the development of E-LKPD oriented towards project-based learning on the material of biological technology innovation and environmental change in semester II biology phase E of SMA 18 Makassar City.

used refers to the Merdeka Curriculum. Analysis of learning outcomes is carried out by reviewing existing materials that can be used to develop products through the National Education Standards Agency (BSNP) textbook and seeing the suitability between learning outcomes and knowledge and skill competencies in the Merdeka Curriculum.

Objective analysis is the formulation of learning objectives based on learning achievements in the independent curriculum. Analysis is the analysis stage that is the main focus for achieving development goals. Where at the objective analysis stage includes the assessment of indicators and learning objectives that are in accordance with the material on biological technology innovation, namely CP 3.1, namely: "Analyzing the types of changes in the causes and impacts of environmental changes and their solutions" and CP 3.2, namely: "Planning and conducting investigations on biological technology innovation and its application".

Design

The design stage is carried out by designing the product according to what is needed. The design stage consists of (1) product design, namely electronic Student Worksheets (E-LKPD) using the supporting application "Heyzine Flipbooks" and (2) research instrument design. The instruments used in this study are the electronic assessment instrument for Student Worksheets (E-LKPD) phase E of SMA, validation of assessment instruments, student response questionnaires, and teacher response questionnaires.

Development

The development stage aims to realize all stages that have been carried out previously and to produce the final product of the electronic Student Worksheet (E-LKPD) that will be developed will meet the following criteria: (1) Meet the quality standards of electronic components of student worksheets to improve learning outcomes, (2) electronic Student Worksheets (E-LKPD) contain discussions of activity units that refer to the learning achievements of the material on innovation in biology technology and environmental changes in phase E of high school according to the independent curriculum, (3) electronic Student Worksheets (E-LKPD) produced are the results of research that has been library from university books, scientific books, scientific articles, (4) electronic Student Worksheets (E-LKPD) contain to improve student learning outcomes. (5) electronic Student Worksheets (E-LKPD) are equipped with pictures, materials, practice questions, supporting information about activities, and self-reflection space.

Furthermore, the results of this development stage will be tested for validity and practicality. The validity test is supposed to be carried out by 2 validators who are lecturers who are experts in the product being

developed. Meanwhile, the practicality test will be carried out by biology teachers as practitioners and high school phase E students who have studied the material on biological technology innovation and environmental change as prospective product users.

Implementation

The implementation phase was carried out with a limited trial of several students in phase E X 5 who had studied the material on innovation in biological technology and environmental change at SMAN 18 Makassar City to obtain the practicality of the student worksheets. The practicality of the electronic Student Worksheets (E-LKPD) was measured from the responses of students and subject teachers in using electronic Student Worksheets (E-LKPD) to make it easier for students to learn the material on innovation in biological technology and environmental change through a questionnaire.

Evaluation

The evaluation stage is carried out by analyzing the effectiveness of learning devices in the form of e-LKPD oriented to STEAM-integrated PjBL on the materials of biological technology innovation and environmental change. Tests are given to students after using LKPD in the form of Learning Outcome Tests (THB). These questions are adjusted to the learning indicators that have been described.

Data analysis

Data analysis is carried out to obtain E-LKPD that is suitable for use and has quality that meets the criteria. At this stage, analysis is carried out using descriptive statistical analysis, which analyzes the results of E-LKPD development research and instruments. The data obtained will later be analyzed in the following way:

a. Analysis of E-LKPD Validity Data

In Content Validity is used to see the agreement of 2 or more experts in assessing the entire product. According to (Setemen, 2018)the content validity used in expert assessment, uses the Gregory formula with the following mechanism: 1) The appointed experts assess the instrument by classifying aspects into very relevant (score 3 or 4) and less relevant (score 1 or 2), 2) the results of the expert assessment are tabulated in the form of a 2x2 matrix, 3) cross tabulation is made, and 4) content validity is calculated using Formula 1.

$$Cv = \frac{D}{A+B+C+D} \quad (1)$$

Information:
CV : Content Validity
A : number of items according to both experts are less relevant.
B : the number of items considered very relevant by expert I and less relevant by expert II.
C : the number of items considered less relevant by expert I and very relevant by expert II.
D : the number of items considered highly relevant by both experts.

The determination of values, A, B, C and D can be seen in Table 1 below:

Table 1. Tabel Gregory

Judges			
		Judge 1	
	Judges Ratings	Irrelevant	Relevant
Judge 2	Irrelevant	A (0)	B (0)
	Relevant	C (0)	D (0)

Validity Categories as follows:

Table 2. Validity Criteria

Mark	Information
0.8 – 1	Very high validity
0.60 – 0.79	High validity
0.40 – 0.59	Medium validity
0.20 – 0.39	Low validity
0.00 – 0.19	Very low validity

b. Analysis of E-LKPD Practicality Data

The data analysis technique for lecturers' and students' responses to the use of e-LKPD learning resources, uses data collection techniques that are carried out to calculate the percentage of practicality of teacher and student responses to the use of e-LKPD learning resources.

The data of teacher and student responses obtained from the questionnaire were then analyzed using qualitative analysis (percentage). The analysis to calculate the percentage of student and teacher responses to each statement in the questionnaire sheet (Riduwan, 2013), used the Formula:

$$\%\dot{R} = \frac{\dot{R}}{5} \times 100\% \quad (2)$$

Information:
%R: Percentage of average response value
R: Average response value
n : Number of Respondents

This average value is referred to the interval for determining the level of media practicality (Riduwan, 2013), which is presented in Table 3 below.

Table 3. Product Practicality Criteria and Intervals

Presentage (%)	Practicality Criteria
81 ≤ Ṙ ≤ 100	Very Practical
61 ≤ Ṙ ≤ 80	Practical
41 ≤ Ṙ ≤ 60	Fairly Practical
21 ≤ Ṙ ≤ 40	Quite Practical
0 ≤ Ṙ ≤ = 20	Less Practical

c. Analysis of E-LKPD Effectiveness Data

The effectiveness of the LKPD oriented to Project Based Learning (PjBl) integrated with STEAM that was developed was analyzed through data on measuring student learning outcomes, this can be seen if what happened before and after the provision of e-LKPD oriented to Project Based Learning (PjBI) integrated with STEAM there was an increase in student learning outcomes which was calculated using the normalized gain formula (N-gain) as follows.

$$\text{N-gain} = \frac{\text{Spost}-\text{Spre}}{\text{Smaks}-\text{Spre}} \quad (3)$$

Information:
Total : score spread on students' initial test
Spost : total score on the final test of the students
Smax : is the maximum possible score that can be achieved.
N-gain : normalized gain

The use of N-gain is to determine how much the learning outcomes of students at SMAN 18 Makassar have increased individually and overall. The criteria for obtaining N-gain can be seen in Table 4.

Table 4. N-Gain Acquisition Category

Limitation	Category
g > 0.7	High
0.3<g≤0.7	Currently
g≤0.3	Low

Sumber: (Meltzer, 2002)

E-LKPD oriented towards PjBL integrated with STEAM for students in phase E can be said to be effective in the learning process if the N-Gain is in the high and medium categories. This means that e-LKPD oriented towards PjBL integrated with STEAM for students in phase E is effective in the learning process.

Result and Discussion

Result

The results obtained in this study are the results of the validity test, the results of the practicality test, and the results of the effectiveness test that will prove the validity, practicality, and effectiveness of the e-LKPD oriented to Project Based Learning (PjBL) integrated with STEAM in the Biology subject for Phase E SMA/MA Students. The E-LKPD product can be seen at: https://heyzine.com/flip-book/fc721b70f1.html

a. *Validity of e-LKPD oriented towards Project Based Learning integrated with STEAM*

The results of the validity analysis of the e-LKPD oriented towards STEAM-integrated PjBL from the two expert validators can be seen in Table 5.

Table 5. Validity data for e-LKPD oriented towards project based learning integrated with STEAM

	Matrix 2X2	Judges 1	
		Irrelevant	Relevant
Judges 2	Irrelevant	A	B
		0	0
	Relevant	C	D
		0	34

CV = 34 0+0+0+34 = 1 (Validity is very high)

The results of the e-LKPD assessment from the two validators in Table 5, the assessment criteria that each represent each statement are in the "Very High Validity" category by obtaining a very relevant score by both experts, namely 1. So, after being reviewed from all aspects, it can be concluded that the e-LKPD oriented towards STEAM-integrated PjBL on the Topic of Biological Technology Innovation and Environmental Change that was developed was declared feasible for use after being revised according to the suggestions given by the two validators.

b. Practicality of e-LKPD oriented towards STEAM Integrated PjBL

The E-LKPD trial was conducted to see its practicality in the learning process. Practicality can be seen based on the responses of biology teachers and students of class X 5 SMAN 18 Makassar. A product is said to be practical if it meets the established practicality indicators, namely the product developed has been valid based on the assessment of expert validators. The results of teacher and student responses to the practicality of E-LKPD can be seen in Table 6 and Table 7.

The results of teacher responses to the e-LKPD oriented towards STEAM-integrated PjBL on the Topic of Innovation in Biological Technology and Environmental Change in Table 6, are included in the very practical category with an overall average percentage of 93.31%. Based on the assessment category of Riduwan's practicality criteria, if it reaches 81 <R ≤ 100, it is stated as very practical. So that the E-LKPD oriented towards STEAM-integrated PjBL that is developed is very practical.

Table 6. Results of Data Analysis of Biology Teachers' Responses to the Practicality of E-LKPD Teaching Materials Oriented to STEAM-Integrated PjBL

Assesment Aspects	Response Presentation (%)	Information
Contents of teaching materials	94.44	Very practical
Presentation in teaching materials	92.50	Very practical
Usage	95.83	Very practical
STEAM integrated learning	91.67	Very practical
PjBL learning steps	91.67	Very practical
Language	93.75	Very practical
Overall average	93.31	Very practical

Practicality criteria: 81%-100% (very practical)

Table 7. Results of Data Analysis of Student Responses to the Practicality of E-LKPD Teaching Materials Oriented to Integrated STEAM PjBL

Assessment Aspects	Response Presentation (%)	Information
Benefit	85.93	Very practical
Usage	86.74	Very practical
STEAM integrated learning	85.61	Very practical
PjBL learning steps	81.06	Very practical
Language	86.74	Very practical
Overall average	85.22	Very practical

Practicality criteria: 81%-100% (very practical)

The results of students' responses to the e-LKPD oriented towards STEAM-integrated PjBL on the Topic of Biological Technology Innovation and Environmental Change in Table 7, obtained an average value of 85.22% so that it can be stated that the e-LKPD oriented towards STEAM-integrated PjBL is very practical.

c. Effectiveness of e-LKPD oriented towards STEAM Integrated PjBL

The effectiveness of e-LKPD oriented towards PjBL integrated with STEAM can be seen by looking at the improvement in students' learning outcomes. The results of the analysis of the effectiveness of e-LKPD products oriented towards PjBL integrated with STEAM show that this teaching material is effective in the learning process as seen in Table 8, the value of the N gain test results for improving learning outcomes.

Table 8. N-Gain Test Result Value of Learning Outcome Improvement

Category	Number of Students	Percentage (%)
High	28	84.84
Currently	5	15.15
Low	-	0.00

Based on Table 8, it shows that the development of e-LKPD oriented towards STEAM-integrated PjBL is on average in the high and medium categories, which means that the developed teaching materials are stated to meet the effectiveness criteria.

Discussion

Research and development of teaching materials has three objectives. The first objective is to produce a product in the form of teaching materials with a valid STEAM-integrated PjBL orientation on the material of biological technology innovation and environmental change. The second objective is to determine the practicality of teacher and student responses to E-LKPD oriented to STEAM-integrated PjBL on the material of biological technology innovation and environmental change. The third objective is to determine the effectiveness of E-LKPD oriented to STEAM-integrated PjBL on the material of biological technology innovation and environmental change. E-LKPD is compiled based on learning achievements with interesting animations or images, learning videos, powerpoints, and game-oriented assignments.

The development of e-LKPD oriented to Project Based Learning (PjBL) integrated with STEAM aims to produce learning resources that can increase the active involvement of students through contextual and meaningful project activities. The PjBL model is designed with systematic stages, starting from formulating basic questions, planning and scheduling projects, to evaluating the process and products of student work. Through these stages, students not only understand the concept theoretically, but also develop critical thinking, collaboration, and problem-solving skills. The use of a project-oriented approach encourages students to be directly involved in the process of finding solutions to real problems, so that learning becomes more meaningful and applicable.

The aspects designed in the development of e-LKPD oriented to Project Based Learning (PjBL) integrated with STEAM include interactive audio-visual presentation, varied and attractive layouts, and the use of high-quality images (High Definition) and learning videos that explain in detail each sub-material, especially on the topic of Biological Technology Innovation and Environmental Change. This non-monotonous visual design aims to provide visual stimuli that can increase the attraction and involvement of students in the learning process.

The presentation of interesting and modern learning media is believed to be able to create a more meaningful learning experience and encourage active participation of students. This is supported by the findings of (Junanto & Afriani, 2016), which states that modern, complete, and innovative technology-oriented

learning can increase students' seriousness in participating in learning activities. In addition to designing teaching materials, at this design stage, research instruments are also designed, namely by determining the type of instrument, assessment scale, and aspects that are assessed. These assessment aspects are arranged systematically and refer to the characteristics of the e-LKPD product being developed, so that the instrument can be used to measure the validity, practicality, and effectiveness of teaching materials appropriately.

The use of E-LKPD teaching materials oriented towards STEAM-integrated PjBL can help support the learning process. Learning activities using digital media oriented towards information and communication technology imply a distance between teachers and students because the learning process and assignments are carried out on a virtual platform. In line with research conducted by (Rahman R S, 2020)that online learning can train students' learning independence, where students have greater involvement in improving observational learning behavior.

The results of the validation of teaching materials show that the STEAM-integrated PjBL E-LKPD can be used as teaching materials on the material of biological technology innovation and environmental change because the teaching materials developed are included in the very high validity category. The validation results show the overall validator score (1) with a very high validity category referring to the category range (0.8-1) so that it can be concluded that e-LKPD is very valid.

The advantages of e-LKPD learning resources oriented towards Project Based Learning (PjBL) integrated with the STEAM (Science, Technology, Engineering, Art, and Mathematics) approach have a number of significant advantages in supporting the 21st century learning process. First, PjBL integration encourages students to learn actively through real project activities that foster critical thinking skills, problem solving, collaboration, and creativity. Second, with the STEAM approach, learning becomes more contextual and interdisciplinary, helping students see the relationship between the concepts of science, technology, engineering, art, and mathematics in everyday life. In addition, the e-LKPD format allows flexibility in learning because it can be accessed digitally anytime and anywhere, while facilitating the use of interactive media that enrich students' learning experiences. Thus, e-LKPD oriented towards PjBL integrated with STEAM not only improves students' conceptual understanding, but also prepares them to become adaptive, innovative individuals who are ready to face future challenges. In line with the results of research conducted by (Novitasari et al., 2023) STEAM-oriented LKPD is used in the implementation of the Project Based Learning (PjBL) model because according to STEAM-oriented LKPD it has several advantages, namely it can increase student interaction and participation, and can meet learning styles students, and can stimulate students' interest and motivation to learn, in addition Riyani (2013) E-LKPD no longer uses paper as raw material, but all information, including images, text, videos, and quizzes, is converted into digital files that can be accessed via smartphones and computers. E-LKPD oriented to STEAM-integrated PjBL that is developed can be used as a learning resource to repeat information about the subject matter. E-LKPD is in the form of a soft file and to access it with Heyzine Flipbooks software that requires an internet connection. The presence of products in learning is more flexible so that it is easy to carry anywhere and can control the content being studied because it is designed by the teacher so that it can be adjusted to the planned curriculum.

The product that has been validated and declared valid by the expert validator, then the implementation process is carried out by testing the practicality of teachers and students. E-LKPD is given to operate the Heyzine flipbooks software in online form. The results of providing teaching materials to teachers and students are then given teacher and student response instruments to test the practicality of the teaching materials. Based on the analysis of the data obtained by looking at the results of teacher and student responses, it can be concluded that the E-LKPD teaching materials oriented towards STEAM-integrated PjBL are practical. According to Arikunto (2010) correct data will provide conclusions that are in accordance with the actual situation. The correctness of data depends on the quality of the instrument or measuring tool of the research object used.

Practicality Test of E-LKPD to see the practicality from the perspective of teacher and student responses. Based on research on teacher responses, there are several aspects given to teachers and students, namely the content of teaching materials, presentation in teaching materials, use, STEAM integrated learning, PjBL learning steps, and language. Based on research on student responses, there are several aspects given, namely the benefits, use, STEAM integrated learning, PjBL learning steps and language aspects. The practicality test of teacher responses and student responses is very practical.

The percentage of teacher assessment with a score of 93.31% is very practical, but it can be seen that the assessment results did not achieve maximum results, namely reaching 100% of the practicality of the teaching materials provided, it can be seen from several factors such as teacher conditions, where 3 biology teachers, teaching materials such as E-LKPD have never been done at SMAN 18 Makassar. With the existence of E-LKPD, teachers can convey information more clearly

and precisely, and be responded to and understood by students quickly and clearly, teachers can use products that have been equipped with several additional features such as images or videos that facilitate learning activities in the classroom, so that teachers can make learning time more efficient.

The results of the student responses are very practical with an average score of 85.22%. According to Yamasari (2010) a teaching material is declared practical if the responses given by teachers and students show a practical category, because E-LKPD has features that are attractive such as videos, assignments, animations/pictures, ppt, and presentation of full color material layouts. Videos can represent biological material in the material on biological technology innovation and environmental change which requires presentation in the form of visualizations that will not make students bored compared to the presentation of text in printed books. Next is a full color layout with a selection of colors that are considered attractive and appropriate as teaching materials, especially for biological technology innovation and environmental change materials.

Based on the explanation that has been explained, it can be said that the E-LKPD teaching material oriented towards integrated STEAM PjBL that has been developed has reflected good teaching materials on the material of biological technology innovation and environmental change. E-LKPD interactive, can accommodate audiovisual media, animations and quizzes in the form of games so that learning content transitions are easy. Research by (Rita Zahara, 2017)that the use of audiovisual media helps students remember and understand the material being taught.

The effectiveness of the developed product is determined through an evaluation in the form of a learning outcome test to see the improvement after the learning process. The increase in student learning outcomes occurs because students have experienced a thinking process. Learning to think emphasizes the process of seeking and finding one's own knowledge through discourse, or discussions carried out in the learning process.

The results of the evaluation of the learning outcome test given showed that the effectiveness criteria were achieved, because the test results were in the high and medium categories. This shows that the teaching materials can help students in organizing learning activities that can be carried out effectively, this has an impact on improving student learning outcomes.

An effective learning process is related to how long students can remember and how far students can understand the subject matter given by the teacher. Based on this, it can be concluded that LKPD oriented to STEAM-integrated PjBL in biology subjects can be said to be effective in the learning process on the material of Biological Technology Innovation and Environmental Change. This is also in accordance with what (Syamsuri et al., 2017) stated that positive student responses can be used as a benchmark that students feel more comfortable with the teaching materials used in the learning process. Most of the students' attention will be focused on the learning process because of the students' interest in the teaching materials and students will not get bored quickly with the ongoing learning, so that the average student learning outcomes are higher. This is in accordance with the results obtained when conducting a learning outcome test on the experimental object. When PjBL-STEAM is implemented properly, it will obtain positive results for students including increasing the ability to use knowledge and increasing understanding of the context in several subject matters (Aguilera & Ortiz-Revilla, 2021).

Conclusion

E-LKPD oriented project based learning (PjBL) integrated with STEAM in biology subjects for SMA/MA phase E students on the material of biological technology innovation and environmental change obtained very high validity results with an average validator assessment score for the overall aspect score of 1. Practicality test based on teacher responses with an average overall aspect score of 93.31%. Practicality test based on student responses with an average overallaspect score of 85.22%. Effectiveness test based on student learning outcomes with an average in the high category of 84.84% and a medium category of 15.15%. Based on the research results of e-LKPD oriented Project Based Learning integrated with STEAM in Biology Subject for Phase E SMA/MA Students which was developed referring to the ADDIE model, namely Analysis, Design, Development, Implementation, and Evaluation. The results of the validity, practicality, and effectiveness tests show that the e-LKPD is in the very high validity category, very practical category, and effective category.

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