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Development of Technology Integrated PJBL Based LKPD to Improve Student Learning Outcomes in Elementary School Mathematics Subjects

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Abstract: Development of LKPD based on integrated PJBL Technology to improve student learning outcomes in elementary school mathematics subjects in grade V SDN 01 Terara using the ADDIE model. This research aims to develop PJBL-based LKPD that is integrated with technology by achieving the level of validity in the development process and the effectiveness of the developed LKPD. The data collected through observation and dissemination of questionnaires to expert experts and user response questionnaires, namely teachers and students. The quality of LKPD is measured based on two main aspects, namely the effectiveness of a product, and validity. The feasibility of the product was obtained through the evaluation of material experts, with a magnitude of 60%, a linguist's assessment of 70%, and a technologist's assessment of 63%. LKPD products based on PJBL integrated technology are said to be effective on the reciprocity of users by teachers by 71% and product users by students by 70.14%. Based on the results of *the posttest* and performance, the technology-integrated PJBL-based LKPD was also declared effective in improving student learning outcomes in mathematics subjects. Thus, it can be concluded that the PJBL-based LKPD product integrated with the technology developed is effective, and valid and suitable for use.

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Introduction

Education is a very important basis in making the generation smart and innovative. One way to improve the quality of education is to develop teaching materials that are relevant to education, which has entered the 4.0 revolution period where we know that all activities have used technology, especially in the field of education. This reality shows that humans can't seem to live without technology. These realities, which are based on the rapid development of science and technology, have a wide impact so that they cannot be avoided but must be faced.

In today's digital era, the right and effective way to deal with the world of education to improve student learning outcomes is to use interactive media during the learning process. Technology has opened the door for educational institutions to implement learning through

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commuting or *mobile phones*. Starting from the emergence of the 2013 curriculum, teachers are asked to be able to use technology and keep up with developments.

In practice, the 2013 curriculum must deal with the impact of the outbreak that has attacked all parts of the world, including Indonesia. Not only about the outbreak that appeared, this was also accompanied by the change of the Minister of Education, so that the 2013 curriculum at that time was replaced with the Independent Curriculum. During the implementation of the Independent Curriculum, the use of technology in the world of education. This gives great hope for teachers to be creative and innovative in facilitating the process of teaching and learning activities.

A very important lesson for students to learn in addition to other general subjects is math lessons. Mathematics has benefits in life, this is because many things can be solved with the concept of mathematics (Khoirunisa et al., 2023). As we know in reality, mathematics is often considered the subject with the lowest interest among students, including elementary school students.

The learning approach that is still dominated by the lecture method is one of the causes of students' low interest in learning. Because students prefer to take in information passively rather than looking for solutions to complex problems. This approach tends not to encourage students to complete maslaah in depth. This is an education that can help students to solve problems from an early age.

PJBL (*Project Based Learning*) or project-based learning is a learning model *Student centered* proposed by the 2013 Curriculum until now in the Independent Curriculum, still uses PJBL learning both in the creation of projects and real activities as the core of the learning itself. Explained by (Yanti & Novaliyosi, 2023) that PJBL-based learning in the world of education has been proven in developing various skills and competencies of students.

The problem that is often found in some schools is the problem with the use of technology. Technology is still not used properly in some elementary schools. However, there are also some schools that have installed technology devices such as computers and tablets. But these technological tools have not been fully utilized in the learning process.

Several studies have provided positive things about the use of technology in teaching and learning activities. For example, one of the studies conducted by (Ayu, 2023) It was concluded that the use of technology in increasing the effectiveness of the student worksheets that have been developed is valid, practical and effective. Thus, technology used positively will be able to enrich the student learning experience.

The results of initial observations conducted at SDN 01 Terara prove that the results of student learning are still relatively low. This is due to the learning process that tends to be monotonous and the lack of use of media and the selection of the right learning model to attract interest in learning mathematics so that they are active and responsive both in the learning process and in the exploration of the real world of students.

Therefore, this research aims to develop technology-integrated PJBL-based LKPD to improve the learning outcomes of elementary school students. With the hope of this development, teachers and students are better prepared to face learning in the digital era. Meanwhile, obstacles in the implementation of PJBL-based LKPD integrated with SDN 01 technology are a challenge in itself. From the issues obtained regarding learning about the

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implementation of LKPD is not in accordance with the KKM that has been determined, which is 70% and has only reached 50% in mathematics subjects. The use of LKPD is still conventional so that the improvement in learning outcomes in mathematics subjects is still very minimal. So that the success of learning results is only 50%, not spared from the explanation of some students regarding complaints about mathematics learning that is not interesting and always boils down to counts. This learning that is considered monotonous by students makes the achievement of understanding only reach 30% in the learning process.

Based on the results of the needs analysis, it shows that there are several aspects that are of particular concern in the development of LKPD which will be developed in the form of LKPD based on PJBL integrated with technology to improve the mathematics learning outcomes of 5th grade students of SDN 01 Terara. There is a 25% interest in the selection of the application of innovative learning models, so that students get an interesting and relevant approach in learning. The other need is the need to integrate technology, which is 35% in the learning process. Furthermore, 30% of this need is the development of PJBL-based LKPD which is specifically designed to support student learning success. The readiness of teachers is an important factor in carrying out teaching and learning activities, which is 20%. Hasur teachers are equipped with an understanding of implementing the PJBL learning model and its integration with technology. Finally, 20% is devoted to material evaluation only, this is very necessary to measure the extent of success achieved in improving student learning outcomes and then make improvements if necessary.

Research Method

According to Sugiyono, in 2018 this research uses research and development (R&D) methods which are a type of research used to make certain products and test how effective the product is (Afidah et al., 2024). The use of this research method aims to develop technology-integrated PJBL-based LKPD products for 5th grade students of SDN 01 Terara. This study uses the ADDIE development model (*Analyzw, Design, Development, Implementation, Evaluation*), because each stage includes revision activities that are very useful for researchers in improving the quality of the LKPD developed. This research was carried out using all stages of the ADDIE development model until the evaluation phase. This development model is most widely used because it has a systematic and detailed performance procedure at the planning stage to the result. In addition, expert validation and field tests are carried out in stages ranging from small group to large group tests. Even to the socialization and dissemination of products developed (Fahrurrozi & Mohzana, 2020).

After expert validation testing was carried out, then a product test was carried out in 2 stages, namely involving 10 students in small group testing and all 5th grade students of SDN 01 Terara totaling 35 students as a large group test. Here are the development procedures used.

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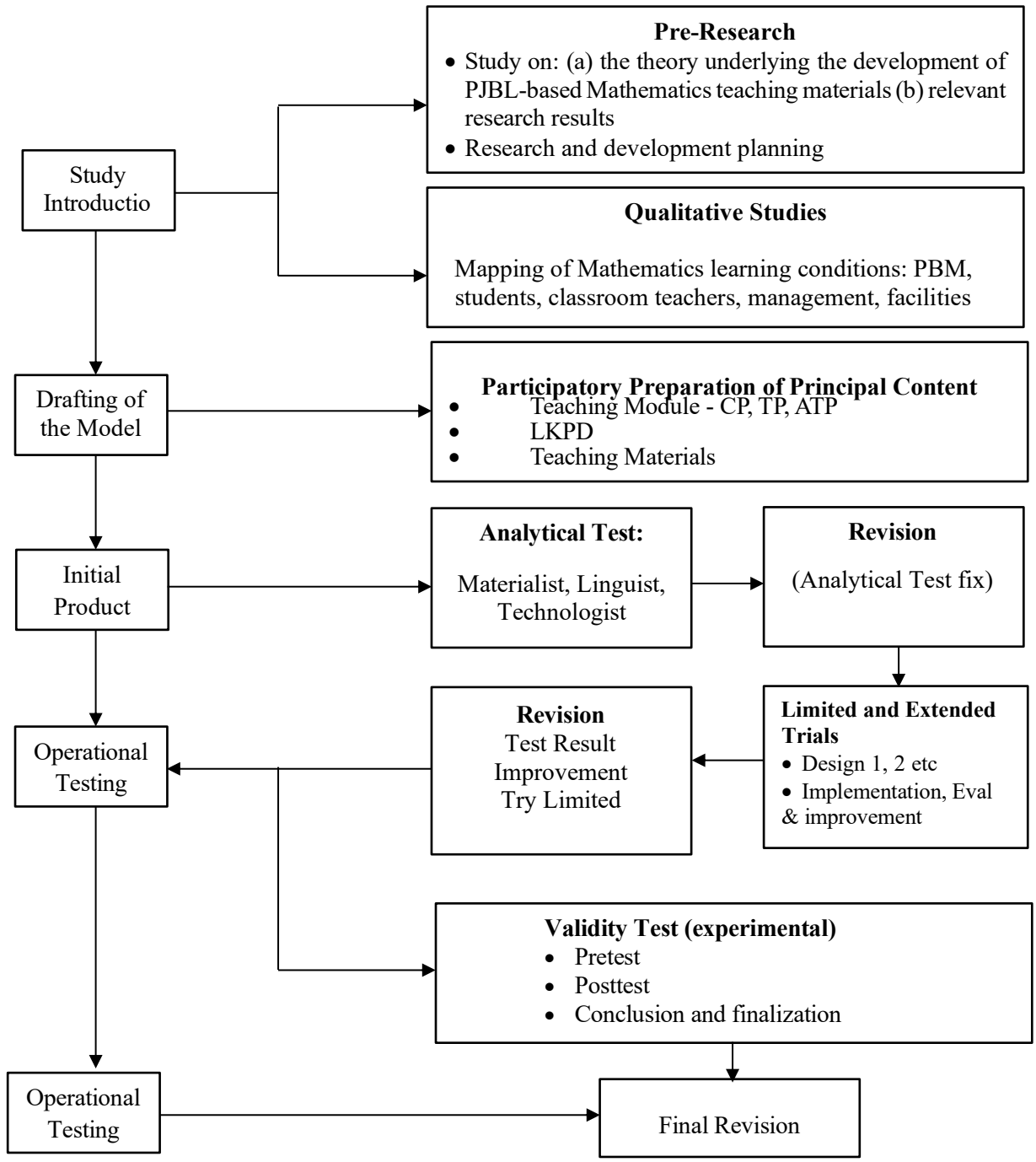

Figure 1. Stages of the Development Process

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Data Collection Methods

The data collection methods used in this study include interviews, then the distribution of product user questionnaires for teachers and students, validation questionnaires for subject matter experts, linguists and technologists, and documentation of learning activities. The distribution of user questionnaires to teachers and students is used to find out and measure the level of effectiveness of a product. Questionnaires given to expert experts are used to measure the level of a product before it is used or in field trials. The guidelines for calculating expert validation questionnaires and user response questionnaires for both teachers and students can be seen as follows.

Table 1. Five-Scale Data Conversion

Value	Score Interval	category
1	$X > X\,i + 1.8\ Sb_i$	Excellent
2	$Xi + 0.6\ Sb_{to} < X \leq Xi + 1.8\ Sb_{to}$	Good
3	$X\,i - 0.6\ Sb_{to} < Xi + 0.6\ Sbi$	Enough
4	$X\,i - 1.8\ Sb_i < X \leq X\,i - 0.6\ Sb_i$	Less
5	$X \leq X - 1.8Sbi$	Very Less

Source: Widoyoko in Yekiastuti & Ikhsan, 2016: 90, (Sihombing, 2025)

Information:

X i (Ideal Average Score) = 1/2 (Ideal maximum score + ideal minimum score)

Sbi (Ideal standard deviation) = 1/6 (ideal maximum score – ideal minimum score)

X = Actual Score

The results of the expert questionnaire assessment, the teacher and student response questionnaire are calculated and then the validity level of the tested product is determined by referring to table 1 which presents the validity criteria of the developed product.

Result and Discussion

This research is a research in the form of development that produces product works in the form of LKPD based on PJBL integrated with technology to improve the learning outcomes of 5th grade elementary school students. Product development is carried out using the ADDIE model. The results of this product development are carried out to prove the feasibility and effectiveness of the product. In general, PJBL-based LKPD has preparation requirements so as to produce a good and attractive LKPD according to the needs of students. These requirements are stated by (Zain et al., 2024) According to Zain, the preparation of the LKPD has 3 conditions to produce a good LKPD, including diktic sharia, construction requirements and technical requirements. Inseparable from the requirements for the preparation of a good LKPD, it is also stated by (Melonia, 2024) that there are several steps that must be taken in the preparation of the LKPD, including analyzing the curriculum first, then compiling a map of needs, determining the title of the LKPD, and finally writing the LKPD.

In the process of developing this product, the ADDIE model is used which goes through an initial stage of the process, namely a needs analysis to help develop the product. The information obtained can be related to fundamental problems that can determine whether the LKPD based on technology-integrated PJBL should be made in mathematics subjects. The first

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stage is the implementation of the preliminary study stage of literature study, field study and observation to teachers and students to produce important notes needed by researchers in developing the product to be created. Here are the results of the interview:

Table 2. Interview Results

No.	Question	Answer
1	In the implementation of learning, what are the preparations of teachers before teaching?	a. What needs to be prepared is to design a learning plan (determine the learning objectives) b. Prepare learning materials and prepare teaching methods and strategies c. Studying student profiles and needs in learning d. Create evaluations and assessments to measure students' abilities
2	Do teachers when teaching mathematics subjects always provide student attraction by providing motivation?	Yes, before starting learning, it would be better to attract the attention of students by providing some motivation, this method I use to attract students' focus level in one direction.
3	What do teachers think about students' ability to learn mathematics?	Talking about students' abilities, of course, it is still divided into several levels. There are students whose catchability is low, medium, and also high. It's just that sometimes this factor can also be one of the problems related to the shaky focus of students' learning. Usually, students like to disturb each other and sometimes feel bored and don't like the learning subjects, so they play.
4	Do teachers when teaching mathematics subjects use guidebooks or package books?	Yes, of course, the use of package books is the main source in teaching and learning activities in the classroom.
5	Have you ever applied *the Project Based Learning model* (creating a project) in your learning activities?	The learning process with PJBL activities has not had time to be implemented. Students learn as usual, given assignments and by lecture methods.
6	Do teachers in teaching and learning activities use Student Worksheet teaching materials?	Yes, I have also made LKPD to be given to students. But it is more conditional for this LKPD. Usually it is more of an ordinary assignment given to students.
7	Have you ever tried to implement a PJBL-based Student Worksheet integrated with technology in mathematics subjects?	For the implementation of LKPD using technology, it has never been. Because so far only assignments or LKPD have been given in the form of print.

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8	Have teachers ever used technology in teaching and learning activities and in this school, are there technological tools such as laptops?	Yes, if you use technology during learning activities. Such as providing viewing materials for students related to the learning carried out. We also used technology during the covid-19 period, that was the beginning of us using technology because of the demands of the situation. Then at our school there are also laptops.
9	Does this school already have its own internet network, such as *Wifi*?	Of course, in our school we already provide *Wifi,* this also makes it easier for us as teachers to find teaching materials that can be adjusted to our needs. Such as providing viewing materials to students.

From the results of an interview with the 5th grade homeroom teacher of SDN 01 Terara related to the student worksheets that are already available but the worksheets are still conventional, teachers have never used technology-integrated PJBL-based LKPD to students. On the other hand, teachers already know the name goole *canva* which can be used to make LKPD and make google *canva* as an access tool for the LKPD. This is due to a lack of understanding related to the use of google *canva* by teachers. On the other hand, teachers and students have used technology during the learning process, as was the case during the *Covid-19* outbreak which resulted in all schools throughout Indonesia being closed or not operating but carrying out online learning activities.

The next stage is product development, where at this stage the preparation of an initial draft of PJBL-based LKPD products is carried out which is integrated with technology in mathematics subjects. In the process of developing PJBL-based LKPD that is integrated with this technology using *the Canva* application. This *Canva application* was chosen because it is considered to be able to produce the required teaching materials due to the availability of teaching material templates from materials to the needs of LKPD. It can even be edited according to the learning needs of teachers.

The next stage is that the product is validated by an expert where the expert includes three elements, namely materials, language and technology that are adjusted to the needs of the validation of the developed product. The number of statements in the questionnaire, both expert validation questionnaires and user response questionnaires, was 15 statements which were then grouped on the results of the calculation using the five-scale score interval formula. The following is a recapitulation of the validation results:

Table 3. Recap of Expert Expert Assessment

Validation Expert	Aspects Assessed	Score	Sum	Maximum Score	Group
Material Expert	Material	20	60	51	Very valid
	Language	16			

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	Use of LKPD	24			
Linguist	Language qualifications	37	70	51	Very valid
	Conformity of language rules	33			
Technologist	Product Design	24	63	51	Very valid
	Learning	9			
	Product Usage	30			

From the results of expert validation regarding the developed product, the results of the validity obtained quite high validity, with an average score above X>63 which is 64.33 which is accompanied by several suggestions from expert expert validation in the revision of the developed product. The next stage is the implementation stage, where the product will be tested for students at SDN 01 Terara using *a mobile phone* to access the LKPD provided in the form of *a QR Code*.

The trial was carried out in 2 phases, namely the small group phase of 10 students and the large group phase of 35 students. In the small group phase, it was deliberately chosen from the student's ability level recommended by the 5th grade homemaker. After conducting a small trial, the next stage is the implementation of the trial in large groups involving all students of class 5A of SDN 01 Terara. After the trial treatment is carried out, students and teachers will fill out a user response questionnaire.

Table 4. Results of User Responses from Teachers and Students

User feedback response	Score	Maximum score	Group
Teacher	71	51	Highly feasible
Student	70,14	51	Highly feasible

Based on the results of the calculation of user responses, teachers, and students regarding the product trials that were developed obtained very high product feasibility validation results. Where the average score of the results of the response of teachers and students is above X>63, which is 70.57 and the product is said to be very feasible. This can be corroborated by the data on student scores of differences from *pretest* and *posttest results* in small groups and large groups. The following is the data on student scores.

Table 5. Small Group Test Results
Results Of Small Group Trials
Calculation Of *N-Gain Score*

No.	Pretest	postest	Post-Pre	Ideal score (100-pre)	N-Gain Score	N-Gain Score (%)
Mean	64,9	84,6	19,7	35,1	0,6	60,04

Table 6. Large Group Test Results

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Results Of Large Group Trials
Calculation Of *N-Gain Score*

No.	Pretest	Posts	Post-Pre	Ideal score (100-pre)	N-Gain Score	N-Gain Score (%)
Mean	64,4	86,68	22,29	35,6	0,66	65,99

From the results *of the pretest* and *posttest* in small groups and large groups that have been carried out in class 5A SDN 01 Terara the implementation of LKPD based on PJBL integrated technology that has been carried out shows that it is effective in improving student learning outcomes. This is evidenced by the results of cognitive tests that showed the average *pretest* and *posttest* gain values in small groups showed low results with an average of 64.9<84.6 with a gain value of 60.4 which is included in the medium category. The *pretest* and *posttest* scores in large groups showed a high score of 64.4<86.69 with a gain value of 65.99 which was included in the high category.

The results of the N-Gain calculation of the two groups showed an increase in average score at the time of *Posttest* but with different numbers. Therefore, it is stated that there is a significant increase in student learning outcomes in small groups and large groups. The results of this study are strengthened by the theory of learning outcomes by (Yogi Fernando et al., 2024) that the purpose of this learning outcome assessment is to be able to find out how much progress students have made in the learning process and find out how effective and successful the learning method used by teachers in the learning process.

Conclusion

Based on the results of the study until the final revision, it can be concluded that the research and development products in the form of LKPD based on PJBL integrated with technology to improve the learning outcomes of elementary school students have in principle passed the feasibility test or validation by experts/experts with results that are in accordance with expectations. The following explanation can be concluded that this development research has produced a technology-integrated PJBL-based LKPD product that is very effective for use in learning. This development procedure refers to the development *of ADDIE* with stages 1) *Analyze*, 2) *Design*, 3) *Development*, 4) *Implementation*, 5) Evaluation of the teaching material product to be developed.

Furthermore, the LKPD based on integrated technology PJBL has been validated by 3 experts, the validation results from material experts produced an actual score of 60 which means that the validity of the LKPD based on technology-integrated PJBL entered the good category. For linguists, the actual score is 70, which means that the validity of the LKPD based on PJBL integrated technology enters the category very well. For technologists, the actual score is 63, which means that the validity of the LKPD based on PJBL integrated technology enters the category very well. Furthermore, the last observer assessed the delivery of researchers in the classroom using the media that has been developed with a total score of 2455 with an average of 70.14 which shows that the product developed in the form of LKPD based on PjBL integrated

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technology in 5th grade students of SDN 01 terara can be categorized as "very good/very feasible to use in the learning process.

Recommendation

This study explains the level of validity and effectiveness in the use of PJBL-based LKPD integrated with the technology developed. This is why the next researcher is expected to continue with the required level of research.

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