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Integrating IoT into Project-Based Learning: A New Approach to Teaching Indonesian Language and Promoting Computational Thinking

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ABSTRACT

This research pioneers the development of Project-Based Learning (PjBL) Indonesian Language teaching materials integrated with the Internet of Things (IoT) to enhance literacy and computational thinking skills among Grade VII students of SMP Negeri 5 Padangsidimpuan. The innovative integration of IoT in PjBL offers a novel approach to language learning, enabling students to engage with real-world problems and develop essential skills for the digital age. The study aims to determine the effectiveness of the developed materials, assess students' responses to the implementation of IoT-integrated PjBL, and evaluate the improvement in literacy and computational thinking skills. Using the ADDIE model, the research involves analysis, design, development, implementation, and evaluation phases. The developed materials have been deemed "Very Good" and are considered a viable alternative learning resource for students and teachers. The findings of this research are expected to serve as a reference for future applied research and inspire further development of the learning materials for mass production and widespread adoption in middle schools.

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Introduction

Indonesian language learning continues to face challenges in its implementation. In the Indonesian language subject, the primary focus is on language skills, which include listening, speaking, reading, and writing (Nasution, 2018). The main issue in introducing Indonesian language teaching to students is that teachers, as educators, are often considered unsuccessful and unable to create meaningful learning conditions. Meaningful learning involves actively engaging students, so the learning process is no longer teacher-centered but more student-focused (Jamila et al. 2021). Meaningful learning develops students' reasoning, thinking skills, and self-concept (Rachmadtullah, 2015). The low levels of thinking and reasoning skills among Indonesian students are evidenced by the results of the PISA tests. One factor contributing to the low quality of education in Indonesia is literacy skills (Chyalutfa et al. 2022). PISA study results show that Indonesian students' reading literacy consistently ranks in the bottom 10 over the past two decades (Marifah et al., 2022; Pratama et al., 2023). The PISA survey also reveals that students' higher-order thinking skills are still very low. These higher-order thinking skills include reasoning, analyzing, and evaluating (Zahro, 2022). One reason for Indonesia's low ranking in PISA is the lack of literacy awareness. Literacy, or literacy competence, is the ability to read and write (Mardliyah, 2019). In educational terms, literacy is not a new concept. In Indonesian language learning, literacy has long been developed. However, literacy is often narrowly defined as reading activities, whereas literacy involves much deeper activities than merely reading. Literacy involves understanding, using, and communicating knowledge. The goal of literacy activities is to obtain and apply the information acquired (Chyalutfa et al. 2022; Zafrullah et al., 2024).

Learning in the 21st century encompasses the integration of literacy, conceptual understanding, skills and attitudes, as well as technological mastery. One important competency is computational thinking (Juldial & Haryadi, 2024). Computational thinking is an essential skill that should be cultivated from an early age to enhance and attract students' interest in literacy. Some scientists believe that computational thinking is a futuristic skill. Computational thinking is not just a skill for programmers or computer scientists (Avci & Denis, 2022; Labadin & Mohamad, 2022). It is a problem-solving skill related to communication, literacy, critical thinking, and creativity. Computational thinking can be used as a foundational skill to face the increasingly competitive and complex challenges of future life (Rahman, 2022). Everyone is expected to have computational thinking skills to meet the demands of everyday life (Monalisa, 2023).

However, the reality is that Indonesian students' computational thinking skills are still very low. The performance of Indonesian students on level 4, 5, and 6 questions was found to be less than 10% on the PISA test, where the characteristics of computational thinking skills align with PISA questions at levels 4, 5, and 6 (Satrio, 2020). A preliminary study conducted by the research team in class VII-1 of SMP Negeri 5 Padangsidimpuan also showed low literacy and computational thinking skills among students. The average percentage of students' literacy skills was 58.89%, categorized as low. As for computational thinking, 19% of students were in the high category, 31% in the medium category, and 50% in the low category. The low literacy and computational thinking skills of students are due to teachers' inability to choose appropriate learning models and the use of unengaging learning media. This results in students becoming lazy, with a lack of motivation and response due to monotonous and uninteresting learning experiences. Teachers need to reflect on their teaching methods in preparing students to maintain their competitiveness (Nasution, 2018). Therefore, there is a need to find creative, innovative, and effective learning models, as well as meaningful learning approaches that are believed to improve literacy and computational thinking skills, such as the implementation of the Project-Based Learning model.

The Project-Based Learning model refers to the philosophy of constructivism (Nelson & Tarigan, 2022). Learning with the Project-Based Learning model is student-centered (Aggeler et al., 2019). Project-Based Learning is a method that emphasizes understanding through discovery, evaluation, interpretation, and synthesis of meaningful information, allowing students to actively engage in solving problems assigned as projects (Krajcik, 2005). The Project-Based Learning model offers a more interesting and meaningful learning experience. Learning materials are linked to real-life issues that are factual in nature. Project-Based Learning is based on cross-disciplinary "design principles" that are often related to what is taught, how it is taught, and how students should be evaluated in Project-Based Learning classroom. Project-Based Learning design principles emphasize the importance of the project as the main vehicle of instruction and the role of students as active participants in the construction of knowledge (Condliffe, 2017). According to research (Acat, 2008), the implementation of Project-Based Learning can enhance students' creativity; equip them

with advanced information and skills; improve their teamwork and collaboration with classmates; and working in groups strengthens mutual trust and friendship. They learn through experience the importance of planning tasks and completing them within the given timeframe. Additionally, students' success in finding new and original solutions to problems encountered in classroom settings without external assistance, as well as applying these solutions in real practice, represents a significant achievement.

In this research, the model is integrated with IoT. IoT is a strategy to extend the reach of always-on Internet connections (Hasanah, 2022). Internet of Things is a technological revolution that represents the future of computing and communications, and its development depends on dynamic technical innovation in a number of important fields (Ramaswamy & Tripathi, 2015; Laghari et al., 2022; Reeve et al., 2021). IoT can be used to enhance the effectiveness and efficiency of learning, as well as provide students with a more personalized and interactive learning experience. Therefore, the urgency of this research is to provide insights into the importance of IoT-integrated Project-Based Learning Indonesian language learning tools to improve the quality of the teaching and learning process, learning outcomes, and the academic achievement of junior high school students, so that our students can be on par with other nations and ready to compete in the 21st century. This research also supports the implementation of a curriculum that emphasizes 21st-century skills, such as literacy, computational thinking, and collaboration

Method

This research was conducted at SMP Negeri 5 Padangsidimpuan in Grade VII for the 2024-2025 Academic Year. The population of this study consists of all seventh-grade students at SMP Negeri 5 Padangsidimpuan, totaly 224 students, and the sample used in the study is 32 students from that population. The development design uses the ADDIE model, which consists of Analysis, Design, Development, Implementation, and Evaluation (Nelson & Tarigan, 2022; Sugiyono, 2024). The procedure for this research is explained through the ADDIE model. Each of the five phases of the model will be described step by step, starting with: Analysis: At this stage, the activities conducted at SMP Negeri 5 Padangsidimpuan include: Analysis of the Utilization of Facilities and Infrastructure: This focuses specifically on the Computer Laboratory at SMP Negeri 5 Padangsidimpuan Analysis of the Learning Process.

Analysis of the Learning Process

This phase aims to understand how the teaching and learning activities take place, including the methods, techniques, and media used by teachers, as well as student responses and engagement in learning. This stage is crucial to assess the effectiveness of the implemented learning process and to identify any needs or issues that need to be addressed. Analysis of the Use of Learning Media: This looks into how students in tenth grade use various learning media in the classroom.

Design

This phase is a follow-up to the analysis phase. In this stage, the researcher conducts the design, which includes: (a) Determining the users of the Indonesian language learning tools using Project-Based Learning integrated with IoT, (b) Identifying the competencies and understanding of indicators that can be achieved through the learning tools, (c) Creating the design of the learning tools that can be used to achieve the competencies as indicated in the communication simulation and digital learning for this semester, (d) Determining the level of mastery of the students after using the research design.

Development

This activity is designed to assist teachers in providing information and material during the learning process. The development steps in this phase include several activities, such as: developing instructional materials according to the syllabus, preparing content in line with the syllabus, and conducting evaluations (including tasks, exercises, etc.). The outcome of this development phase is a set of structured products: a teacher's book, a student book, and student worksheets, all aligned with the applicable competencies, as well as questionnaires to measure the validity and responses of the research subjects.

Implementation

The implementation for the transition to summative evaluation activities and other strategies that apply the teaching and learning process.

Evaluate

Formative evaluation is carried out at the end of each face-to-face session (weekly), while summative evaluation is conducted after the entire activity has concluded (semester). Summative evaluation measures the final competencies of the subject or the learning objectives that are intended to be achieved.

The data collection techniques used include interview sheets, questionnaires, observation sheets, literacy skills tests, and computational thinking tests. The data analysis technique employs a product feasibility validation analysis with the calculation of the validation level as follows (Sugiyono, 2024).

$$Percentage = \frac{Total\ validation\ score}{highest\ score}\ x\ 100\ \%$$

Score Interval of Assessment Results	Criteria
0 % - 20 %	Very Unacceptable
21 % - 40 %	Unacceptable
41 % - 60 %	Fairly Acceptable
61% - 80 %	Acceptable
81 % - 100 %	Very Acceptable

After obtaining the percentage of the product feasibility validation test, the next step is to analyze the practicality of the product using the formula.

$$\%\ p = \frac{score\ obtained}{\sum n}\ x\ 100\ \%$$

After obtaining the practicality percentage of the developed product, the next step is to perform the conversion as shown in the table below.

No	Percentage	criteria
1	0,00% − 20 %	Very Low Practicality / Not Practical
2	20,1% − 40 %	Low Practicality / Less Practical
3	40,1% − 60%	Moderate Practicality / Fairly Practical
4	60,1% − 80 %	High Practicality / Practical
5	80,1% − 100 %	Very High Practicality / Highly Practical

In the student responses, the formula used is $p = \frac{n}{N}\ x\ 100\ \%$. Next, to determine the improvement in Numeracy Literacy and Computational Thinking of middle school students, the N-Gain formula is used (Swaminathan et al., 2024).

$$g = \frac{posttest\ value - pretes}{100 - pretes}$$

After obtaining the gain test results of the developed product, the next step is to interpret the N-gain classification as shown in the table below.

No	Average N-Gain	Classification
1	N – Gain ≥ 0,7	High
2	0,7 > N-Gain ≥ 0,3	Medium
3	0,3 > N-Gain	Low

Results and Discussion

This research focuses on developing a product in the form of Indonesian language learning tools based on Project-Based Learning integrated with IoT to enhance students' literacy and computational thinking skills. The development process follows the ADDIE model, which includes Analysis, Design, Development, Implementation, and Evaluation stages. The learning tools, integrated with IoT, have been validated by validators and tested. The data analysis was conducted according to the completion stages, resulting in a product that is valid, practical, and effective, ultimately aimed at improving the literacy and numeracy of 7th-grade students at SMP Negeri 5 Padangsidimpuan.

Need Analysis

In the Needs Analysis stage, observations of Indonesian language learning were conducted at SMP Negeri 5 Padangsidimpuan for Grade VII. This activity focused on three observed aspects: learning tools, the learning process, and student behavior during and outside of learning activities. Each of these aspects is detailed into several components. The learning tools aspect includes the syllabus, lesson plans, and media and learning resources. The learning process aspect encompasses teaching methods, teacher activities in presenting material, time management, ways to stimulate student interest in learning, classroom management techniques, and forms and methods of evaluation. The student behavior aspect examines behavior inside and outside the classroom. Based on the observation results, the learning tools used at SMP Negeri 5 Padangsidimpuan follow the Merdeka curriculum. The learning resources consist of textbooks available in the library. Learning media include videos, projectors, and blackboards. The methods employed are lectures, discussions, and Q&A sessions.

In the curriculum analysis stage, the researcher analyzed the curriculum used at SMP Negeri 5 Padangsidimpuan, which follows the national curriculum. Based on interview results, the characteristics of students during the learning process indicate that teachers still primarily use lecture methods, leading to less creative teaching approaches. Students are not very active in learning analysis activities. Therefore, there is a need for materials in the learning tools based on Project-Based Learning integrated with IoT. Additionally, teachers tend to treat all students' needs the same, without differentiating according to students' individual needs, which should be aligned with the differentiated Merdeka curriculum.

The Indonesian language materials in the learning tools show that students' literacy and computational thinking skills are still low. The average percentage of student literacy ability is 58.89%, categorized as low. In terms of computational thinking ability, 19% fall into the high category, 31% into the moderate category, and 50% into the low category. The low literacy and computational thinking skills are attributed to teachers' insufficient selection of appropriate learning models and less engaging learning media. To enhance literacy and computational thinking, there is a need to develop learning tools using Project-Based Learning integrated with IoT.

Design Phases

After completing the analysis stage, the researcher proceeded to the design stage. In this stage, the researcher creates the design of the learning media product based on the analysis stage, which includes:
Preparation of Instruments: In the design phase regarding the material for formulating learning objectives, a literacy test for 7th-grade junior high school students has been developed in the form of Indonesian language literacy consisting of 20 multiple-choice questions, as well as computational thinking using 10 essay questions. The preparation of these instruments is aligned with the learning indicators. Making the Flowchart Media: The flowchart serves to assist in designing the navigation structure from one screen to the next, thereby clarifying the media production design. Below is the flowchart for the learning media:

Flowchart Design

Main Menu Design: If the user is a teacher who has never used the application, they must register to obtain a teacher code. Once the teacher code is acquired, students can complete exercises and add data for teachers, students, and materials according to the teacher's code. Users (students) can work on the practice questions after filling in their students' number code, Name, and Teacher Code. After completing the practice questions, the scores obtained by the students can be accessed by the teacher through the Teacher Login feature. In the Teacher Login feature, the teacher must enter their Username and Password, after which they can check the data containing the results obtained by the students.

Teacher Page Design: On the teacher page, the teacher can add student data, lesson plans, and learning materials. Student Page Design: On the student page, students can only input their data and download learning materials. Assessment Instrument**:** Assessment instrument to obtain data on the process and results of developing appropriate learning tools, it is essential to prepare data collection instruments. The validity, practicality, and effectiveness of a product can be determined through the use of these instruments. The designed instruments include: validity instrument: validation sheet, practicality instrument: questionnaire, effectiveness instrument: literacy and computational thinking tests.

Develop

At this stage, the preparation of data collection instruments is also carried out. In the development stage, validation of the draft or initial design of the research instruments that have been prepared is conducted. Validation is performed by expert validators and practitioners, namely lecturers and physics teachers. The data resulting from the activities carried out by the researcher during the development stage is as follows:

Table 1. Results of Validation for Literacy and Computational Thinking Questions

Aspects Assessed	Average Score		–	Category
	Literacy	Computational thinking test		
1. The indicators used are aligned with the Basic Competencies	3	4	3,5	Acceptable
2. The questions represent all the indicators to be achieved	5	5	5	Very Acceptable
3. The questions created adhere to the indicators	3	5	4	Acceptable
4. Use standard terminology	3	4	3,5	Acceptable
5. Each question includes an answer key and scoring criteria.	4	4	4	Acceptable
Average	**3,6**	**4,4**	**4**	Acceptable

Based on the product analysis, a score of 4 can be calculated using the formula where the highest score is 5. Therefore, the value is 80%, which can be categorized as acceptable. In analyzing the learning motivation questionnaire of students before and after using the Project-Based Learning integrated with IoT instructional tools, it is important to understand the changes or improvements in learning motivation that occur during the learning process. The analysis can be conducted by comparing the results of the questionnaire before and after the Project-Based Learning intervention.

Table 2. Validation Results of the Motivation Questionnaire by Lecturers and Teachers

No	Aspect Assessed	Assessment Results	Criteria
1	Format	4,5	Very Acceptable
2	Content	4	Acceptable
3	Language	4	Acceptable
Total Average		**4,167**	**Very Acceptable**

Based on the product analysis, a score of 4, 167 can be calculated using the formula where the highest score is 5. Therefore, the value is 83,33%, which can be categorized as very acceptable. The lesson plan implementation observation sheet is used as a guideline to assess the quality of instructional media based on its use in the classroom. In addition, the lesson plan implementation sheet serves as material for evaluating and revising the developed product. This observation sheet consists of two answer options, "yes" and "no." The observer can make an assessment by checking one of the available options. A remarks column is also provided for general notes or comments related to the learning implementation.

The research instrument in the form of a questionnaire was validated before use. The questionnaires created were the student response questionnaire and the teacher response questionnaire. After the questionnaires were developed, they were validated by validators who provided suggestions and

feedback on the questionnaires, followed by an assessment based on the aspects listed on the validation sheet to ensure the questionnaires were valid.

Table 3. Validation Results of the Teacher and Student Response Questionnaire

No	Aspects Assessed	Assessment Results		Average	Criteria
		Teacher	Student		
1	Format	5	5	5	Very Acceptable
2	Content	4	5	4,5	Very Acceptable
3	Language	4	5	4,5	Very Acceptable
Average		4,33	5	4,67	Very Acceptable

The validation results conducted by lecturers and physics teachers on the lesson plan used in this research can be summarized in the table below:

Table 4. Results of the Lesson Plan Feasibility Analysis

No	Aspects Assessed	Assessment Results	Criteria
1	Subject identity	4	Acceptable
2	Formulation of indicators	3,85	Acceptable
3	Selection of teaching materials	4	Acceptable
4	Selection of learning resources	4	Acceptable
5	Selection of learning media	4,25	Acceptable
6	Selection of learning model	4	Acceptable
7	Learning scenario	4,15	Acceptable
Total Average		**4,167**	**Very Acceptable**

Based on the product analysis, a score of 4, 167 can be calculated using the formula where the highest score is 5. Therefore, the value is 83,33%, which can be categorized as very acceptable

Product learning materials Project-Based Learning integrated IoT

The design of the Project-Based Learning differentiated learning tools integrated with IoT results in an initial product called Prototype I. Subsequently, the learning tools integrated with IoT will be reviewed and assessed by validators. The results obtained from the validators will serve as recommendations and references for revising the Project-Based Learning tools. The suggestions and feedback from the validators will be used as a basis for improving the product, resulting in Prototype II. The recommendations and revisions from the validators regarding the learning tools product are as follows.

Table 5. Suggestions and Feedback Provided by Both Validators

Suggestions and Feedback	
Validator I Before Revision	**Validator I After Revision**
Adjust the content of the teaching module to align with the basic competencies	In accordance with the expected competencies.
Simplify the sentences in the writing of the learning tools.	The sentences in the learning tools have been simplified.
Clarify the images included in the learning tools	The images in the learning tools are now clear

Suggestions and Feedback	
Validator I Before Revision	**Validator I After Revision**
It is advisable to add the sentence 'Students are expected to be able to' in the learning objectives.	Learning objectives have been added "Students are expected to be able
Ensure neatness in the pagination of the learning tools.	*The learning tools are neat in providing pages*
Clarify and enlarge the images.	The images contained in the learning tool are clear and enlarged
Include the material and tasks that will be assigned to the students."	The learning tools include materials and assignments that will be given to students

Furthermore, the validation results and suggestions from the validator are used as a reference by researchers in revising the learning tools developed. The revised results of prototype I are called prototype II, if prototype II has been declared valid by the validator, then the learning device is tested with limited distribution in class VII of SMP Negeri 5 Padangsidimpuan. Validity data on learning materials for IoT-based learning devices can be seen in the attachment. The assessment results can be seen with the following summary:

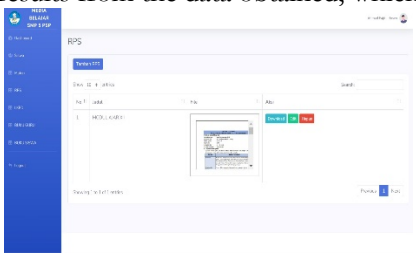
Tabel 6. Average Results of Validator Assessment

Aspects Assessed	Assessment Results	Criteria
Content Feasibility	3,25	Acceptable
Accuracy and Truthfulness of the Material	3,5	Very Acceptable
Presentation of Components	3,5	Very Acceptable
Language Usage Components	3,25	Acceptable
Completeness of Components	3,25	Acceptable
Graphic Feasibility	3,37	Very Acceptable
Average	3,35	Very Acceptable

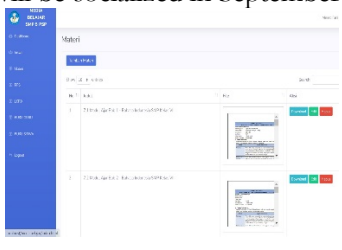
Based on table 6 above, the average assessment result from the validators for the Project-Based Learning tools developed is 3.35, which, when expressed as a percentage, falls within the valid category. This result concludes that the Project-Based Learning tools can be used with minor revisions.

Implement

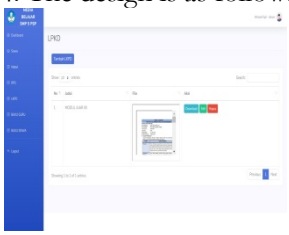
After validation, the next step is to conduct a product trial in the form of user training activities and results from the data obtained, which will be socialized in September 2024. The design is as follows:



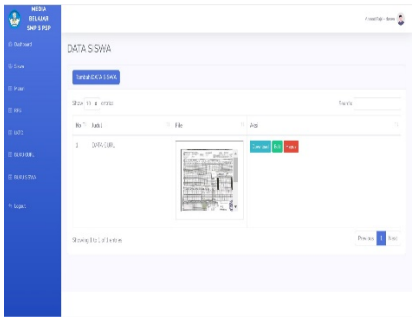
RPS



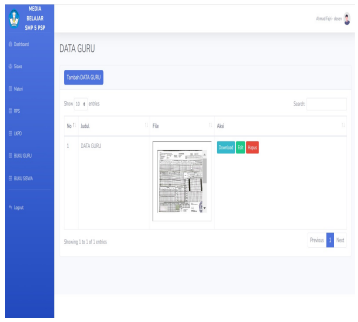
Lesson



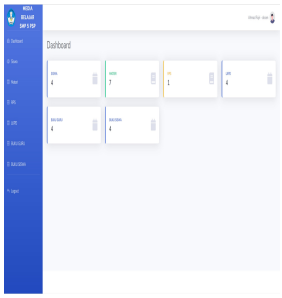
LKPD



Teacher Data



Student Data



Dashboard

Evaluate

In the evaluation, a distribution of response data from the pre-test and post-test on literacy and computational thinking is conducted, followed by data analysis to determine how the ability has improved after the development of the learning tools.

Tabel 7 Assessment of Learning Tools

Validator	Average Assessment	Criteria
Literacy Instrument	3,6	Very Acceptable
Computational Thinking Instrument	4,4	Very Acceptable
Motivation Instrument	4,167	Very Acceptable
Student Response	4,33	Very Acceptable
Teachers' Response	5	Very Acceptable
Lesson Plan	4,167	Very Acceptable
Media	3,35	Acceptable
Average	4,144	Very Acceptable

Discussion

In this research, the development of learning tools oriented towards Project-Based Learning with differentiated integration of IoT is conducted for seventh-grade students at SMP Negeri 5 Padangsidimpuan to enhance literacy and computational thinking. The development of this learning media is carried out through five stages, which include analysis, design, development, implementation, and evaluation. The developed product consists of physics learning tools that meet the qualifications of being feasible and valid based on the results of the research conducted by the validators.

The overall average assessment of the developed learning tools is 4.144, categorized as very good. According to the assessment criteria, where the highest score is 5, this results in 82.88%. It can be concluded that the learning tools are highly feasible for use. This is in line with previous research that states that the Project-Based Learning model for the Indonesian language is effectively used by students of the Technical Education and Computer Engineering program at the Faculty of Teacher Training and Education at Dehasen University, Bengkulu. The average implementation of the project model, student activities in the project model, and student responses to the practicality of the project model resulted in a calculated score of 93%[29].

The combination of Project-Based Learning (PjBL) and the Internet of Things (IoT) in Indonesian language educational resources has proven to be an effective strategy for boosting students' literacy and computational thinking abilities (Zafrullah et al. 2024; Wawan et al. 2022; Wei et al. 2021). By integrating real-world projects that leverage IoT, students can participate in genuine learning experiences that foster a deeper comprehension and application of language principles. Through the PjBL method, students collaborate on projects that require them to design, create, and implement IoT-based solutions to solve real-world challenges. This approach helps students cultivate vital skills such as problem-solving, critical

thinking, and communication, while also enhancing their literacy in the Indonesian language (Shin, 2021; saad & Zainuddin, 2024).

Incorporating IoT into PjBL also offers students the chance to develop computational thinking skills, including data analysis, algorithm design, and programming. By using IoT devices and platforms, students can gather and analyze data, build predictive models, and develop interactive systems that showcase their grasp of language concepts. Studies have indicated that students involved in PjBL with IoT integration show notable advancements in literacy and computational thinking skills compared to those not engaged in such programs. The use of IoT in PjBL also boosts student motivation and engagement, as they work on real-world projects with tangible results. In summary, the creation of PjBL Indonesian language teaching materials integrated with IoT holds the potential to improve students' literacy and computational thinking skills, equipping them for success in an increasingly technology-driven environment.

The creation of Project-Based Learning (PjBL) materials for teaching Indonesian, combined with the Internet of Things (IoT), offers a new way to improve reading and thinking skills (Weng et al., 2022; Widyaningrum et al., 2024). This study shows how PjBL and IoT can be used in learning Indonesian. The study explains how IoT can help in learning languages, especially in reading and thinking. Using IoT in PjBL lets students solve real-world problems, helping them learn language concepts better. The research also shows how IoT projects can improve thinking skills in language learners. The results suggest that IoT-integrated PjBL can boost reading and thinking skills in language students. Additionally, this study adds to the research on using technology in language learning. It provides ideas on how to create and use IoT-based language learning materials. These findings are useful for teachers, curriculum planners, and policymakers who want to use technology in language education.

This research is novel because it combines Project-Based Learning (PjBL) with the Internet of Things (IoT) in teaching Indonesian. This method helps improve reading and thinking skills (Bell, 2010; Atzori et al. 2010). This is one of the first studies to use IoT in PjBL for learning Indonesian, showing how technology can help in language education. The use of IoT in PjBL allows students to work on real projects. They use language skills in real situations and learn to think like computers. This is different from past studies that used technology in language learning but did not focus on the IoT in PjBL. This research is also novel because it focuses on learning Indonesian, which is not often studied with technology. The results are important for teachers and policymakers in Indonesia and elsewhere. They showed that IoT in PjBL can improve reading and thinking skills in language learners. In summary, combining PjBL with IoT in Indonesian language teaching is a new way of learning languages. It can help students perform better and prepare for a world where technology is important.

Conclusion

In conclusion, this research has successfully developed Indonesian language learning devices using Project-Based Learning (PjBL) integrated with the Internet of Things (IoT), which has been shown to enhance students' literacy and computational thinking skills. The developed learning devices meet the criteria of being "very good", making them a valuable alternative learning resource for students and teachers alike. The findings of this research have significant implications for language education, highlighting the potential of IoT-integrated PjBL to improve language learners' outcomes. It is hoped that the results of this research will serve as a reference for future applied research and inspire further development of the educational device products, ultimately leading to mass production and widespread adoption in middle schools. By leveraging the power of IoT and PjBL, we can provide students with engaging and effective learning experiences that prepare them for success in the digital age.

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Conflict of Interest

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

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