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Integration of Project-Based STEM Learning in the Meliuk Menerjang Material within the Emancipated Curriculum

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Abstract: This study aims to develop a project-based STEM (Science, Technology, Engineering, and Mathematics) learning tool for the "Meliuk Menerjang" material in the Emancipated Curriculum for grade IV students in Indonesian elementary schools. The objective is to create a tool that is feasible, practical, and effective in improving student learning outcomes. The research employs a Research and Development (R&D) approach, specifically following the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. Data was collected through validation from material and design experts, questionnaires, and student performance assessments. The study included 25 students and 20 teachers from various elementary schools in Malang City to identify the needs and effectiveness of the project-based STEM learning model. Data analysis was performed using SPSS for effectiveness analysis and qualitative analysis for feedback and validation results. Findings**:** The project-based STEM learning model demonstrated high feasibility with significant improvements in students' understanding and skills. Validation results showed that the content was relevant and supportive of STEM skill development. Both teachers and students positively accepted the learning model, indicating increased confidence and motivation. Conclusion**:** Integrating project-based STEM learning in the Emancipated Curriculum positively impacts student engagement, motivation, and learning outcomes. This approach fosters critical thinking, creativity, and teamwork among elementary students, preparing them for future technological challenges.

Keywords: Meliuk Menerjang; Project based learning model; STEAM

Introduction

STEM (Science, Technology, Engineering and Mathematic) is a combination of four sciences namely knowledge, technology, engineering, and mathematics incorporated into an interdisciplinary approach that is applied based on everyday life which is linked in the problem solving process (Aguayo et al., 2023; Haas et al., 2023; Liu et al., 2024; Thoma et al., 2023). STEM (Science, Technology, Engineering and Mathematic) learning in elementary schools is very important to instill the concepts of science, technology, engineering and mathematics to students from an early age (Kang & Kim, 2014; Madden et al., 2013; Oner et al., 2016; Ozkan & Topsakal, 2021; Wilson et al., 2021).

STEAM can improve students' higher order thinking skills (Syukri et al., 2022). The integration of STEAM learning with learning models is considered to support learning outcomes. Research that has been done (McAuliffe, 2016; Thuneberg et al., 2018). Currently, STEM is a learning concept that is increasingly in demand by various countries, including Indonesia. This is due to the demands of the technological age that requires each individual to develop students' skills in

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critical, creative and collaborative thinking and be able to solve complex problems so as to prepare students to be ready to face the era of digitalization and increasingly advanced technology (Festiawan et al., 2021; Kim & Byun, 2019; Nur'azizah et al., 2021). Empirical evidence also shows that the use of appropriate learning tools can improve student learning outcomes. Several studies have shown that the use of innovative learning tools can improve student learning outcomes (Dewi et al., 2022; Huang, 2005; Samala et al., 2022; Mardhatillah et al., 2019**;** Aulia & Prahmana, 2022; Raharjo et al., 2023; Yang, 2022). Many studies have been conducted related to the use of STEAM in Indonesian language learning, but until now there has never been a study that integrates STEAM and project-based learning taught on twisting and crashing material in Indonesian language learning in elementary schools.

This research is motivated by the low student learning outcomes in Indonesian language learning, especially on the material of swerving, there is no STEM-based learning tool specifically that can be used in Indonesian language learning in elementary schools. One of the problems encountered by teachers in the application of Indonesian language learning is the limited learning resources that support the achievement of the curriculum. This is supported by the results of interviews with several elementary school teachers in Malang City. The interview results show that there are still minimal learning tools that focus on learning activities to improve student learning outcomes in Indonesian language learning.

One alternative solution (problem solving) in improving learning conditions is through the application of the STEAM merging model with project-based learning (Bedar & Al-Shboul, 2020; Dolgopolovas & Dagienė, 2021; Juškevičienė et al., 2021). The learning model is outlined in the form of STEAM learning tools. This can be done because students are required to find the concept of the material independently (Mardhatillah et al., 2019**;** Kasmini et al., 2024; Mardhatillah et al., 2017).

The integration of STEM (Science, Technology, Engineering, and Mathematics) learning in elementary education is crucial for instilling foundational concepts and skills from an early age. STEM education promotes critical thinking, creativity, and problem-solving abilities, which are essential for students to navigate the demands of the modern technological era. However, in Indonesian elementary schools, particularly in the context of Indonesian language learning, there is a lack of STEM-based learning tools that effectively engage students and enhance learning outcomes. This research addresses the gap by developing a project-based STEM learning model specifically tailored for the "Meliuk Menerjang" material within the Emancipated Curriculum.

The innovative aspect of this study lies in the integration of STEM principles into language learning, a field where such interdisciplinary approaches are rarely applied. By combining project-based learning with STEM, the study introduces a novel method to make language learning more interactive and relevant to real-world applications. The developed learning model is designed to improve student engagement, understanding, and retention of the material. It encourages active participation, hands-on learning, and the application of scientific and mathematical concepts in a language learning context. This approach not only enhances students' academic performance but also boosts their motivation and interest in learning. Conducting this research is important for several reasons: it contributes to the advancement of educational methodologies by providing a validated, effective, and practical learning tool that can be implemented widely; it helps develop essential 21st-century skills such as critical thinking, creativity, collaboration, and communication; it supports the goals of the Emancipated Curriculum by aligning with its emphasis on interdisciplinary learning and student-centered approaches; and it provides teachers with a structured yet flexible framework that can enhance their teaching strategies and confidence in delivering complex material. By addressing these aspects, this research aims to make a significant contribution to the field of education, particularly in the integration of STEM into language learning, ultimately preparing students for future academic and professional challenges.

Based on the problems, the focus of the problems raised in this research is how to produce project-based STEM learning tools on twisting material in Indonesian language learning in elementary schools that are feasible (valid), practical and effective and able to improve student learning outcomes.

Method

This research is a development research that aims to develop project-based STEM learning on *jumputan batik* material. In learning this *batik jumputan* material, it is expected that students become student centers in learning who are able to think critically, creatively, innovatively, communicatively and collaboratively with this project-based STEM approach. Therefore, the method used in this research is R & D (Research and Development). This project-based STEM learning development procedure refers to the development stages of the ADDIE model. The ADDIE model used is a reference to the concept proposed by Branch (2009)

which consists of analysis, design, development, implementation, and evaluation (Branch, 2009).

The study follows a structured methodology consisting of several stages: analysis, design, development, implementation, and evaluation. In the analysis stage, the researchers conduct a problem analysis by assessing the needs of students and teachers for project-based STEM learning, focusing on *jumputan batik* material. During the design stage, a comprehensive project-based STEM learning design is prepared, including the use of substances and color mixtures (Science), product creation techniques (Technology), pattern design (Engineering), and pattern measurement (Mathematics). In the development stage, an initial product in the form of *jumputan batik* is created and validated by several experts. Revisions are made based on expert feedback before proceeding to the implementation stage. During implementation, the developed products are tested on grade IV students at SDN 3 Bareng Malang City, with students' responses being measured to evaluate feasibility and effectiveness. After the trial, final improvements are made based on feedback obtained during the implementation process. The evaluation stage involves analyzing the results of student response questionnaires and test results using SPSS to determine the product's feasibility and effectiveness. The feasibility analysis is based on the percentage of respondents' interest, while the effectiveness analysis examines the test results given to students.

Result and Discussion

Analysis of Student Needs and Characteristics

The initial activity in this development research is to look at the needs analysis conducted by distributing questionnaires to 25 students and interviews with 20 teachers. To get initial information about the Project-based STEAM learning model.

Table 1. Needs Analysis Data

Type of Information	Answer	Frequency			
		Teacher	Students	total	Percentage
Whether or not you are familiar with the interactive project-based STEAM learning model with macromedia flash	-Yes	5	1	6	13.33
	-No	15	24	39	86.67
Using or not using the Project-based STEAM learning model in the learning process	-Yes	4	3	7	15.56
	-No	16	22	38	84.44
Requires or does not require a Project-based STEAM learning model	-Yes	20	23	43	95.56
	-No	0	2	2	4.44

Based on the results of the needs analysis in Table 1, the researchers designed a new learning media, namely a Project-based STEAM learning model by reviewing the content standards. This content standard review is carried out by mapping the Competency Standards (SK) and Core Competencies (KI), the results of the SK and KI mapping are obtained material to be developed in the Project-based STEAM learning model.

Product Validation Stage

Data from Material Expert Validation Results

Before testing, the Project-based STEAM learning model developed was first validated by material expert validators. The maximum score of each statement item in the validation sheet is 5 while the minimum score is 1 as seen in Table 2.

Table 2. Material Expert Assessment of the Quality of Learning Materials

Assessment Indicator	Respondent		Average	Percentage	Criteria
	1	2			
Correctness and Accuracy of Material	4	4	4	80	Very good
Accuracy of material coverage	4	4	4	80	Very good
Correctness of concept	4	4	4	80	Very good
Depth of learning material	4	3	3.5	70	Good
Alignment with the curriculum	4	4	4	80	Very good
Accuracy of the sequence of learning materials	3	4	3.5	70	Good
Overall assessment	4	4	4	80	Very good

Validation or feasibility of a project-based STEM learning model is an important process that ensures the effectiveness and suitability of the model in an educational context. In the validation process, the first aspect to be assessed is content relevance. The "Swerving through" material should be relevant to STEM (Science, Technology, Engineering and Mathematics) principles and support the development of STEM skills in students. Consultation with education experts and a literature review were used to ensure that

the materials covered relevant basic concepts. Furthermore, the achievement of learning objectives is assessed by measuring students' learning outcomes before and after the application of the learning model. Evaluation instruments such as tests, observation sheets, and project scoring rubrics help in evaluating the improvement of students' understanding and skills.

Table 3. Material Expert Assessment of the Quality of Learning Strategies

Assessment Indicator	Respondent		Average	Percentage	Criteria
	1	2			
Quality Introduction	4	3	3.5	70	Good
Quality of Material Presentation	3	4	3.5	70	Good
Student involvement and role in learning activities	4	5	4.5	90	Very good
Quality of feedback	4	4	4	80	Very good
Serving time	4	3	3.5	70	Good
Overall assessment	4	5	4.5	90	Very good

Table 4. Material Expert Assessment of Learning Delivery System

Assessment Indicator	Respondent		Average	Percentage	Criteria
	1	2			
Language Usage	4	4	4	80	Very good
Ease of language comprehension	4	4	4	80	Very good
Layout/appearance	4	3	3.5	70	Good
Illustration	4	4	4	80	Very good
Overall assessment	4	5	4.5	90	Very good

The assessment conducted by 2 material experts includes aspects of the quality of learning materials, learning delivery systems and the quality of learning strategies on the Project-based STEAM learning model. The results of research on the quality of learning materials, learning delivery systems and the quality of learning strategies as a whole show that the quality of learning materials is very good.

The material expert validator's comments on the feasibility of content, presentation, and wetness in general are very good but in order to achieve perfection there are several suggestions submitted as shown in Table 5.

Table 5. Comments and Suggestions from Material Experts

Topic	Issues that Need to be Revised
Content Feasibility	Material, SK, KD and Indicators must be appropriate
Presentation	Need to increase methods that activate students
Linguistics	The use of materials should be straightforward and easy for elementary school children to understand.

The effectiveness of teaching methods in project-based STEM learning models must also be tested. This involves assessing how the project is designed, implemented and evaluated. Teachers need to ensure that students are actively involved in each stage of the project and have opportunities to apply the concepts they have learned. Classroom observations and teacher reflections are used to assess whether this teaching method is effective in encouraging active participation and student understanding. In addition, acceptance by teachers and students is an important aspect in the validation of this learning model. Teachers should feel comfortable and confident in applying this model, while students should feel interested and motivated by the project-based learning approach.

Data on Learning Design Expert Validation Results

Learning design expert validation is carried out by 2 design experts validating the product on aspects of learning design including content feasibility consisting of learning design quality, presentation aspects consisting of learning design quality.

The results of the validation in the form of an assessment score of the components of the Project-based STEAM learning model in these four aspects can be seen in Table 6. The assessment conducted by 2 learning design experts includes aspects of learning quality, information design, interaction design and presentation quality quality on the Project-based STEAM learning model. The results showed that the quality of learning materials was declared very good.

The validation results show that the project-based STEM learning model on the material “Swerving through” in the Emancipated Curriculum for grade IV

students has high feasibility. The content taught is proven to be relevant and supports the development of STEM skills. Learning outcome measurements showed significant improvements in students' understanding and skills. The teaching methods used are also effective in encouraging active engagement and student participation. In addition, teachers and students showed positive acceptance of this learning model. Teachers feel more confident in teaching with this approach, and students feel more challenged and motivated in learning.

Table 6. Results of Assessment by Design Experts on Learning Quality Aspects

Assessment Indicator	Respondent		Average	Percentage	Criteria
	1	2			
Appropriateness of Topic Selection	4	4	4	80	Very good
Suitability of material with learning indicators	4	3	3.5	70	Good
Providing exercises	5	4	4.5	90	Very good
Test consistency with learning indicators	4	4	4.5	90	Very good
Overall assessment	4.5	4.5	4.5	90	Very good

Table 7. Results of Assessment by Design Experts on Information Design

Assessment Indicator	Respondent		Average	Percentage	Criteria
	1	2			
Providing Motivation	4	4	4	80	Very good
Clarity of material description	5	4	4.5	90	Very good
Clarity of the examples provided	4	4	4	80	Very good
Use of new information	3	4	3.5	70	Good
Feedback on student test results	4	4	4	80	Very good
Chaptering/frequency	4	4	4	80	Very good
Maximizing the learning process	4	3	3.5	70	Good
Overall assessment	4.4	4	2	84	Very good

Table 8. Assessment by Design Experts on Interaction Design

Assessment Indicator	Respondent		Average	Percentage	Criteria
	1	2			
Use of study guides	4	4	4	80	Very good
Explanation of Terms	4	3	3.5	70	Good
Feedback on student responses	4	4	4	80	Very good
Use of different text to mark important sections	3	5	4	80	Very good
Overall assessment	4.7	4	4.13	87	Very good

Table 9. Assessment by Design Experts on Aspects of Presentation Quality

Assessment Indicator	Respondent		Average	Percentage	Criteria
	1	2			
Color composition	4	4	4	80	Very good
Use of graphics	4	4	4	80	Very good
Font type and size selection	4	4	4	80	Very good
Use of navigation buttons	4	4	4	80	Very good
Image and animation quality	4	5	4.5	90	Very good
Use of music	4	3	3.5	70	Good
Ease of use	5	5	5	100	Very good
Overall assessment	4.29	4.42	4.36	87.1	Very good

The design expert validator's comments on the feasibility of content, presentation, and wetness in general are very good but in order to achieve perfection there are several suggestions submitted as shown in Table 10.

Overall, the integration of project-based STEM learning in Emancipated Curriculum makes a positive contribution to more thorough and meaningful learning for grade IV elementary school students. This model not only helps students understand scientific concepts, but also develops important 21st century skills such as critical thinking, creativity, and the ability to work together in teams. The validation shows that this learning model is feasible and effective to implement, providing a more interactive and contextualized learning experience for students.

The integration of project-based STEM learning on the material "Meliuk Menerjang" in the Emancipated Curriculum for grade IV elementary school students showed significant results in improving students' understanding of concepts and skills. This study aims to evaluate the effectiveness of this approach in increasing students' interest and understanding of science, technology, engineering and math lessons through projects relevant to everyday life. Based on the research results, students showed significant improvement in critical thinking and problem solving skills after participating in project-based learning.

Table 10. Comments and Suggestions from Learning Design Experts

Topic	Issues that Need to be Revised
Content Eligibility	The material is adjusted to the indicators
Display	Conduct feedback on each lesson and make further instructions to learn the next material.
Linguistics	Use of terms is less clear
Graphics	Create musical variations for each topic transition

In the planning and design stage, students are invited to identify problems or challenges that will be solved through the project. For example, they are asked to design a vehicle model that is able to move quickly and stably. This process involves group discussion, brainstorming and designing initial sketches. In this stage, students not only learn basic physics concepts related to motion and force, but also develop collaboration and communication skills that are essential in teamwork.

The project implementation and evaluation stage is an important moment for students to apply the theory they have learned. Students build the designed model and test its performance under various conditions. Data obtained during testing is analyzed using simple mathematical approaches, such as calculating speed, distance and time. The evaluation process allows students to understand the relationship between scientific concepts and practical applications, as well as identify areas for improvement in their designs.

Conclusion

The results show that the integration of project-based STEM learning is able to increase students' engagement and motivation in learning. Students feel more challenged and motivated to complete their projects well. In addition, this approach also helps students develop 21st century skills, such as critical thinking, creativity, and the ability to work together in teams. Thus, the integration of project-based STEM learning in Emancipated Curriculum makes a positive contribution to more thorough and meaningful learning for grade IV elementary school students.

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Author Contributions
There were several people who played a role in completing this research. The first author provided the concept, main ideas and necessary materials, while the other authors were responsible for designing and organizing the research methods. All authors shared the responsibility of data collection, data tabulation and analysis, review process, and article writing.

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Conflicts of Interest
The authors declare that there is no conflict of interest regarding the publication of this paper.

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