STEAM PJBL BASED MATHEMATICS LEARNING BUILDING SPACES INTEGRATED WISDOM LOCAL

Nur Ngazizah[1],
Inggrit Nada Prahasdita[2]
[1,2]Muhammadiyah University Purworejo,
Indonesia
ngazizah@umpwr.ac.id
inggritnadaprahasdita@gmail.com

ABSTRACT

This research aims to develop learning tools using the STEAM PjBL approach. The type of research used is a research and development of the ADDIE model which consists of five stages, namely analysis, design, development, implementation and evaluation. The result is to produce teaching modules and student worksheets (LKPD) for Mathematics learning material for building cubes and blocks based on STEAM PjBL which is integrated with local wisdom in the form of Purworejo batik and Javanese script. This learning tool provides students with the opportunity to: 1) Knowledge about the properties of objects in the surrounding environment (Science), 2) Use ICT in the form of laptops to look for Purworejo batik design ideas (Technology), 3) Students design mesh patterns for building space and Purworejo batik (Engineering), 4) Students explore their creativity in the art of drawing on Purworejo batik and Javanese script (Art), 5) Students apply the concept of scale to drawing mesh patterns of spatial shapes (Mathematics). So it can be said that the teaching modules and LKPD using the STEAM PjBL approach have received qualifications worthy of being applied in the teaching and learning process and the products that have been developed can be used by teachers in learning. The implications of this research are useful in helping students to develop 21st century skills, namely 4C skills in accordance with the independent curriculum.

Keywords: teaching module, mathematics, STEAM PjBL approach

INTRODUCTION

Emotional intelligence has become a key skill in the 21st century or what is known as the 4Cs: creativity, critical thinking, collaboration and communication (Thornhill-Miller et al, 223). These skills are important to prepare students to face future challenges. However, conventional learning approaches are not effective in integrating 4C skills into the curriculum (Arnyana, 2019). In general, conventional learning is a teacher-centered approach where the teacher is at the core of all class activities which include explanations and discussions (Mugo et al, 2024). Recent studies show that schools still tend to use conventional approaches that focus on abstract and theoretical learning, so that essential 21st century skills are not developed and students do not know the meaning of the learning they are learning (Fahrudin et al, 2021; Naela et al, 2021). This condition can become an obstacle for students to adapt to an increasingly complex and dynamic societal environment. Therefore, a paradigm shift in learning approaches is needed to ensure that every student acquires essential skills so that they are ready to face real problems.

STEAM (science, technology, engineering, arts, mathematics) based learning tools with a Project-based Learning (PjBL) approach offer innovative solutions that carry out creative transdisciplinary teaching for critical thinking, especially emphasizing design, collaboration and contextual learning (Quingly et al, 2019). The use of learning tools can influence students' character, so it is hoped that teachers can apply learning tools effectively (Ngazizah et al, 2022). Development of effective STEAM-based learning tools takes into account students' contextual and individual needs and uses technology creatively in the learning process. The implementation of PjBL STEAM-based learning tools in the independent curriculum is very important to overcome the weaknesses of conventional learning because this approach integrates various scientific disciplines which allow teachers to find ways to encourage student creativity (Perignat et al, 2019). The integration of several disciplines in the STEAM approach provides a structure that is aligned with 21st century competencies (Deák et al, 2024). In the academic realm, the STEAM approach has become an interesting and promising method (Kumar et al, 2023).

It was concluded from several studies regarding the development of PjBL STEAM-based learning tools that the products produced in the form of lesson plans, LKPD, e-LKPD, modules or e-modules were declared valid, practical and effective for increasing student activity, elaboration ability, concept mastery and creativity (Dewi et al, 2021; Wandari et al, 2018; Putri & Effendi, 2023). Project Based Learning (PjBL) is a learning method that focuses on using innovative and complex activities as the main means in the learning process. This model allows students to explore learning material in various ways that provide benefits through experimental collaboration (Diana & Saputri, 2022). However, none of these studies have developed a

STEAM PjBL-based mathematics teaching module for spatial construction material. Even though spatial construction material often poses its own challenges for students. The main obstacles found were difficulty visualizing objects in three-dimensional space and a lack of understanding of the relationship between sides, space and volume (Putri & Feriyanto, 2019; Shara & Puji, 2021). Apart from that, learning Mathematics is considered a tedious learning process (Ngazizah et al, 2017). Therefore, it is necessary to develop a mathematics learning tool based on STEAM PjBL spatial building materials that is suitable for use.

Based on the explanation above, the researcher limited the problem due to the researcher's limitations, namely that this research only carried out the development of mathematics learning tools using the STEAM PjBL approach for class V in phase C material on building space, sub-chapter, cubes and blocks with the title "STEAM PjBL Based Mathematics Learning on Building Spaces Integrated Wisdom Local". The aim of this research is to create teaching modules and student worksheets (LKPD) for mathematics on spatial building materials based on STEAM PjBL integrated with local wisdom that are suitable for use.

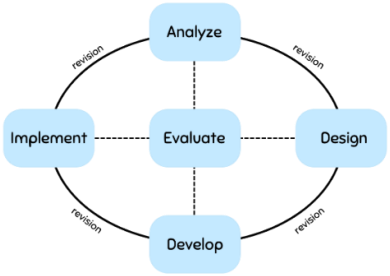
METHOD

This development research was carried out using the ADDIE model with the product developed in the form of a STEAM PjBL-based spatial building material teaching module and student worksheets. There are five research stages in the ADDIE model, namely analysis, design, development, implementation and evaluation (Setiyorini, 2020) which are shown in Figure 1. Data collection techniques include observation, interviews and questionnaires. Product testing was carried out by 2 material experts, 2 media experts, and 2 design experts. The instrument test using the content validity test was carried out using the Gregory formula and a cross tabulation was made to the content validity criteria which can be seen in table 1. The instruments created were guided by the learning planning rules according to Minister of Education and Culture Regulation number 16 of 2022. In this research, qualitative descriptive analysis techniques were used to process data resulting from reviews from experts and quantitative descriptive analysis techniques to process data in the form of numbers from assessment sheets.

Table 1:
Content validity criteria

Value Range	Criteria
0,8 – 1	Very high validity
0,6 – 0,79	High validity
0,40 – 0,59	Medium validity
0,20 – 0,39	Low validity
0,00 – 0,19	Very low validity

Picture 1:
ADDIE development model



Source: Setiyorini, 2020

FINDINGS AND DISCUSSION

This research develops a mathematical learning tool for cube and block geometric materials based on STEAM PjBL using the ADDIE model which consists of 5 steps, namely analysis, design, development, implementation, and evaluation. The first stage of curriculum analysis found that spatial building material was the material studied by class V students. Needs analysis through interviews and observations showed that mathematics learning had not used the PjBL STEAM approach and tended to use the lecture method so that students were passive in learning activities therefore, based learning was needed. Projects to develop 21st century skills.

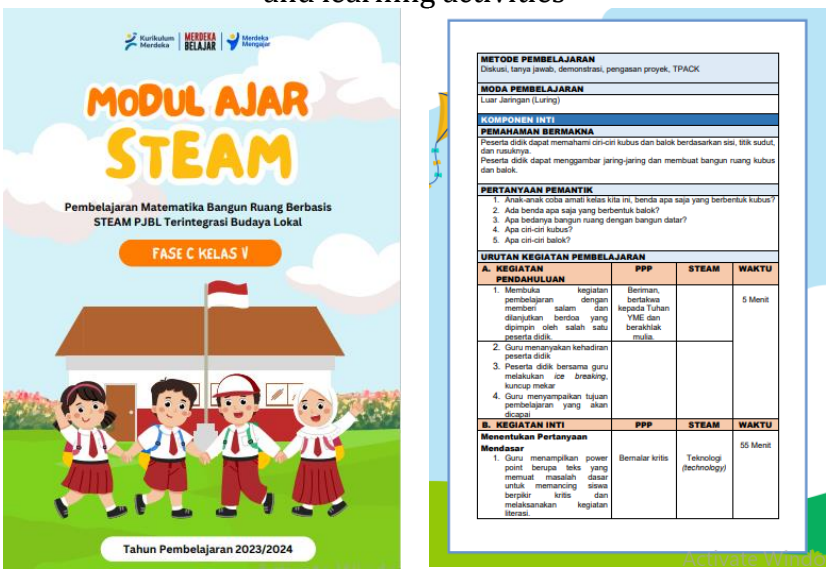
The second is design, at this stage the researcher designs a teaching module on the material of cubes and blocks by collecting references, designing learning objectives, learning activities and assessments. The design of PjBL STEAM-based learning can be seen in table 2.

Table 2:
PjBL STEAM-based learning design

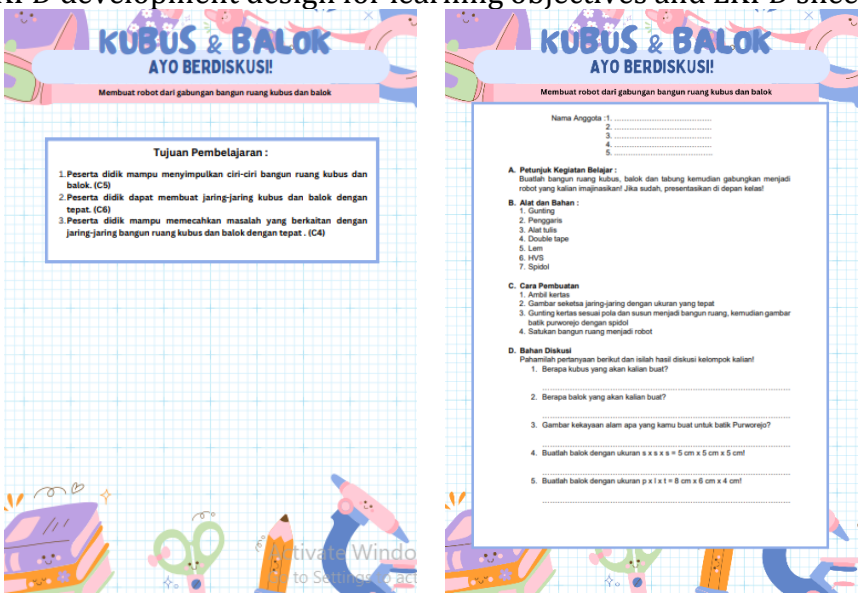
Indikator	Keterangan
STEAM *(Science, Technology, Engineering, Art, and Mathematics)*	S : Knowledge about the properties of objects in the surrounding environment
	T: Using ICT in the form of a laptop to look for Purworejo batik design ideas
	E: Students' ability to design spatial nets which are then implemented into physical structures
	A: Students explore their creativity in the art of drawing on Purworejo batik and Javanese script
	M: Students apply the concept of scale to drawing geometric mesh patterns.
Sintaks model pembelajaran Project Bases Learning (Heny et al, 2021)	1. Start with the essential questiom
	2. Design a plan for the project
	3. Create a schedule
	4. Monitor the students and the progress of the project
	5. Assess the outcome
	6. Evaluate the Experience

Learning tools in the form of STEAM-based teaching modules contain three important learning planning documents as referred to in Minister of Education and Culture Regulation Number 16 of 2022 Article 3 paragraph (3), namely learning objectives, learning activities and assessments. Then, the LKPD consists of a cover, identity, purpose, activity instructions, tools & materials, how to make it, and discussion material. The development design can be seen in figures 2 and 3.

Picture 2:
Design for the development of the cover section of the teaching module and learning activities



Picture 3:
LKPD development design for learning objectives and LKPD sheets



Third, the development stage, at this stage the learning tools are developed according to the results of the analysis and design. The development of teaching modules and LKPD is carried out based on the PjBL STEAM approach. The product has been validated by the validator, the products before and after revision are presented in table 3.

Table 3:
Products before and after revision

Before	After
 Cube & block writing	 Given a white outline so it doesn't blend in with the background
 LKPD cover	 Added spacing between name and class

Fourth, the implementation phase carried out research trials in class V of elementary school. The learning process is carried out in accordance with the instructions of the PjBL STEAM-based teaching module with detailed activities as follows, 1) Students are divided into several groups, 2) The teacher distributes the LKPD and is presented with project activity instructions, 3) Students conduct discussions then write on the LKPD, 4) Students use technology in the form of a laptop to look for references to Purworejo batik. After that, draw a net of cubes and blocks decorated with Purworejo batik and Javanese script. Then, students design the net into a spatial shape, 5) Students combine the spatial shapes into a robot and present the results in front class. Some student activities are presented in pictures 4 and 5.

Fifth, the STEAM PjBL-based teaching module and LKPD products that have been developed were evaluated by several experts, namely 2 material experts, 2 material experts and 2 design experts. The product assessment results are presented in table 4.

Table 4:
Content validity criteria

No	Expert	Category	Value	Criteria
1	Material expert	Teaching module products	0,67	High validity
2	Media expert	LKPD products	0,7	High validity
3	Design expert	LKPD products	1	Very high validity

Based on the assessment by experts, it is declared that the development product is feasible. In the table above, it can be concluded that the teaching module developed received a score of 0.67 so it is included in the high validity criteria. The results of the media expert's assessment of the product being developed received a score of 0.7, which is included in the high validity criteria. The results of the design expert's assessment of 1 are included in the very high validity criteria.

Picture 4:
Students use laptops to access the internet looking for Purworejo batik references

Picture 5:
Students decorate building patterns using local wisdom

Based on the results of data analysis, the learning tools developed, namely teaching modules and LKPD based on STEAM PjBL integrated with local wisdom of Purworejo batik and Javanese script, received high validity and very high validity qualifications so that they could be declared suitable for application in the learning process. STEAM is a form of constructivist learning because it focuses on exploration and collaboration, where students will discover and develop their own knowledge and understanding

through projects (Mariana et al, 2023). This encourages students to master subject matter and use technology as a means to explore knowledge concepts. Certainly, each project phase integrated in STEAM learning is expected to develop relevant and essential skills, both for now and in the future. For this reason, the STEAM learning stages presented for grade 5 elementary school students also consider the use of technology in completing projects involving three fields of study, namely Javanese language in the form of local wisdom, Purworejo batik and Javanese script; SBdP in the form of drawing and coloring skills; Mathematics on cubes and blocks.

The PjBL learning model focuses on students, which is in line with 21st century needs. In this model, students play an active role in learning, which can increase their understanding of science subject matter and encourage active participation in the learning process. Using the right learning approaches and tools can maximize the achievement of learning goals. The application of innovative and creative learning techniques can also increase students' interest in participating in learning and effectively improve their learning achievements (Diana et al, 2024).

The advantage of this development product is that it makes learning fun and challenging because there are STEAM-based projects that encourage students to be creative and active. Apart from that, learning tools are designed based on the abilities of phase C or grade 5 students. Teachers are also helped to organize learning so that they can achieve the expected learning objectives. The disadvantage of the learning tools developed is that the learning tools can only be used for class V spatial building material, sub-chapter cubes and blocks. Apart from that, this learning device has been tested for validity and is declared feasible, but its effectiveness has not been tested. The implications of this research are useful in helping students to develop 21st century skills, namely 4C skills in accordance with the independent curriculum

CONCLUSION

The PjBL STEAM-based learning tool integrated with local wisdom was declared feasible based on an assessment from design experts with a score of 0.67 in the high validity category, media experts with a score of 0.7 in the high validity category and very high validity from the design experts with a score of 1. So it is suitable for use in the learning process . The teaching modules and LKPD developed make it easier for teachers to achieve learning goals and students can develop 21st century abilities, namely 4C skills (critical thinking, creative thinking, communicating, and collaborating) so that this teaching module is recommended for teachers to use PjBL STEAM-based learning tools that are in line with independent curriculum.

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