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Implementation of a Steam-Based Module Integrating Mathematics Geometry to Cultivate Vocational Values

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Abstract

A teacher's role involves creating an environment that stimulates and fosters critical thinking skills. One effective approach to promoting vocational values is through integrating mathematics geometry lessons with STEAM-based methods by developing learning modules that serve as independent teaching materials accessible to students. This research aims to design and develop a mathematics geometry learning module for fifth-grade students to instill vocational values. The study follows a Research and Development (R&D) methodology, employing the ADDIE development model. Data collection methods include interviews and questionnaires, analyzed through qualitative and quantitative techniques.The findings demonstrate that the quality of the developed learning module, as validated by five experts; two media specialists from BBPPMPV BOE East Java and three mathematics teachers from Al-YA'LU Excellent Elementary School in Malang meets high standards. Media experts rated the module's design feasibility with an average score of 3.46, categorized as "highly feasible." Subject matter experts evaluated the module's content feasibility with an average score of 3.91 ("highly feasible"), linguistic feasibility at 3.93 ("highly feasible"), and contextual feasibility at 4 ("perfect").

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INTRODUCTION

The importance of fostering vocational values in elementary school education has become increasingly evident in recent times, as these efforts aim to enhance the interest and motivation of students toward innovation and creativity. This initiative is crucial since many elementary school students today remain passive, displaying a lack of creativity and innovation in cognitive development. It is the responsibility of educators to establish an environment that encourages and develops creative and innovative thinking abilities among students.

Creative learning has emerged as a vital component in improving the quality of education. Creativity involves producing something new or better, stimulating the imagination of students, and encouraging continuous development. Teachers play a key role in introducing and fostering creative thinking in the classroom. To facilitate effective learning, a systematic learning module has been developed to instill vocational values through mathematics lessons on geometry, incorporating STEAM (Science, Technology, Engineering, and Mathematics) methodologies. This STEAM-based geometry learning module is designed to address challenges faced by students and nurture vocational values as part of the classroom learning process.

Cultivating vocational values, which foster innovative, creative, competitive, and sustainable character traits, requires sociocultural and structural support (Jaedun et al., 2014). From a sociocultural perspective, fostering vocational values is expected to meet various needs, including: (1) enhancing cognitive and psychomotor skills in students (Hutagaol et al., 2021); (2) supporting character education (Anisa and Sri, 2024); and (3) developing a positive appreciation for work, building a strong work ethic, thinking creatively beyond conventional approaches, identifying alternative solutions, and adapting to change (Silaen et al., 2024).

Teaching materials constitute a core component of the educational process, as effective teaching cannot take place without them (Islami and Armiati, 2020). For educators, teaching materials provide a reference for delivering subject matter, while for students, they serve as a learning resource that outlines the competencies to be mastered.

Integrating vocational values into elementary school education through mathematics geometry lessons is exemplified by projects such as creating building models. By fostering creativity, students develop innovative, productive, competitive, and sustainable characteristics that will benefit them in the future (Sungkar et al., 2023). Vocational education fosters student independence while aligning with their developmental stages. Maximizing the benefits of instilling vocational values requires classroom teaching processes that emphasize vocational character development. This development is facilitated through creative, innovative, and productive learning, particularly within STEAM-based geometry lessons (Bertrand and Namukasa, 2023). Vocational values help develop positive character traits in students, influencing their daily lives and supporting the development of essential soft skills. Creativity plays a pivotal role in building critical, innovative, adaptive, and solution-oriented thinking skills, all of which are critical in today's globalized world. However, educators face challenges in nurturing these characteristics due to limited infrastructure and resources available for teaching and learning activities (Aryanitha and Agung, 2022).

In line with the functions and goals of national education, it is clear that education at all levels, including elementary school (SD), must be conducted systematically to achieve these objectives. This includes shaping the character of students to enable them to compete, maintain ethical conduct, demonstrate moral behavior, exhibit courtesy, and interact effectively with society (Nisak, 2016).

METHODS

This study employed a Research and Development (R&D) approach. R&D involves a series of processes or steps aimed at developing new products or improving existing ones in a way that ensures accountability (Nanda et al., 2017).

The research utilized the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), a systematic framework for addressing learning challenges and

developing educational resources tailored to the needs and characteristics of students (Maydiantoro, 2019). The model consists of five steps: (1) Analyze, (2) Design, (3) Develop, (4) Implement, and (5) Evaluate. It is commonly used in creating various educational products, such as textbooks, learning modules, instructional videos, and other resources (Sugiono, 2020).

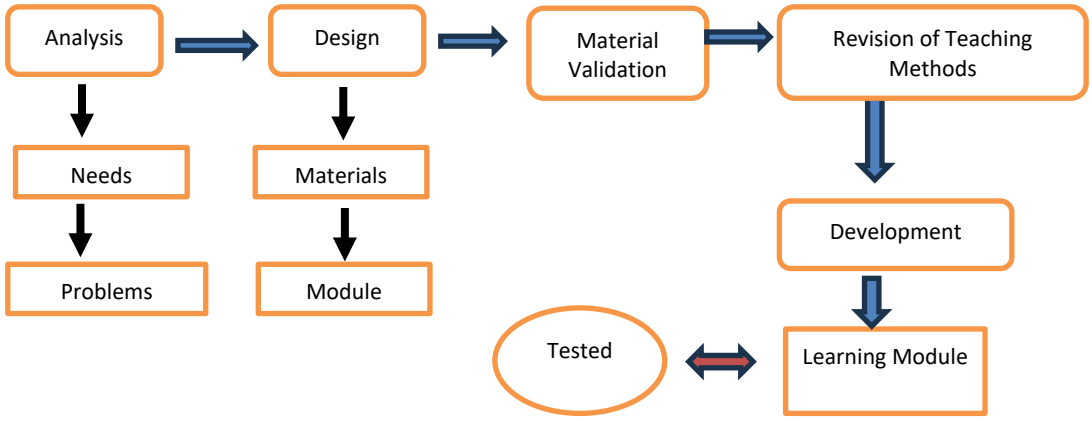

Figure 1. The development of a mathematics geometry integration module using STEAM steps

Data collection is a critical step in research, as the main objective is to gather relevant data (Sugiyono, 2014). In this study, data were collected using evaluation sheets that assessed the module's feasibility, practicality, and effectiveness. These instruments are described as follows:

2.1 Module Feasibility Evaluation Sheet

The module's feasibility was evaluated by media and subject matter experts, who provided feedback and suggestions for improvement. The validators included, two media experts specializing in vocational education from BBPPMPV BOE East Java (Balai Besar Pengembang Penjamin Mutu Pendidikan Vokasi). Three subject matter experts, who were fifth-grade mathematics teachers at AL-YA'LU Excellent Elementary School in Malang.

2.2 Module Practicality Questionnaire

Practicality refers to the ease of use of the developed learning module by users (students). A practical module facilitates meaningful, engaging, enjoyable, and beneficial learning experiences for students while enhancing their creativity (Alfiriani, 2018). The practicality questionnaire was distributed to both teachers and students.

2.3 Module Effectiveness Test

The module's effectiveness was assessed through a performance test conducted by the researcher with students. The instrument's validity was evaluated through content validity, which involved consulting several experts (expert judgment).

RESULTS AND DISCUSSION

3.1 Research Results

3.1.1 Instrument Validation

The learning module went through several validation phases, including feasibility tests by subject matter and media experts, as well as practicality tests involving teachers and students. The validity and reliability of the evaluation instruments were assessed using the Content Validity Ratio (CVR) and point-biserial correlation for the practicality instrument. Before being implemented, expert judgment was sought to validate the product. Feedback obtained during this process was used to refine the module. The evaluation instruments adhered to the standards established by BSNP.

The validation process was carried out based on professional assessments by expert groups to determine the validity of the content and the clarity of the language. The final stage of validation involved analyzing the results obtained. The CVR calculations indicated that the instruments were valid, with scores of 1 from both media and subject matter experts. Instrument reliability was assessed using the Intraclass Correlation Coefficient (ICC) through SPSS version 26. The results are as follows:

Table 3.1 Reliability Test Results for Module Feasibility (Media Experts)
ANOVA and Intraclass Correlation Coefficient (ICC)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig
Between People		1.714	27	.063		
Within People	Between Items	10.286	1	10.286	28.588	.000
	Residual	9.714	27	.360		
	Total	20.000	28	.714		
Total		21.714	55	.395		

Grand Mean = 3.43

Intraclass Correlation Coefficient

	Intraclass Correlation[b]	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	-.700[a]	-.849	-.448	.176	27	27	1.000
Average Measures	-4.667[c]	-11.245	-1.622	.176	27	27	1.000

The reliability test of the feasibility instrument by two media experts, using interrater reliability via ICC, demonstrated no significant differences in the evaluations provided by the raters ($p > 0.05$). The ICC analysis yielded a satisfactory reliability coefficient of rxx = 0.7, indicating that the evaluation instrument was consistent and reliable. The ANOVA analysis further supported these findings, with a significance value of 1.00, confirming no significant differences in the evaluations from the raters.

Table 3.2 Reliability Test Results for Module Feasibility (Subject Matter Experts)
ANOVA and Intraclass Correlation Coefficient (ICC)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig
Between People		3.750	27	.139		
Within People	Between Items	3.738	2	1.869	5.332	.008
	Residual	18.929	54	.351		
	Total	22.667	56	.405		
Total		26.417	83	.318		

Grand Mean = 3.58

Intraclass Correlation Coefficient

	Intraclass Correlation[b]	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	-.252[a]	-.357	-.072	.396	27	54	.995
Average Measures	-1.524[c]	-3.727	-.251	.396	27	54	.995

The reliability test of the feasibility instrument by three subject matter experts, also using ICC, similarly showed no significant differences between raters ($p > 0.05$). The ICC reliability coefficient of rxx = 0.252 confirmed that the instrument was consistent and reliable. The ANOVA analysis yielded a significance value of 0.995, further confirming uniformity in the evaluations.

In summary, the CVR and ICC analyses demonstrated that the evaluation instruments were valid and consistently measured the intended constructs, confirming their reliability (Hendryadi, 2017).

3.1.2 Expert Assessments of the Module

Table 3.3 Aggregate Scores for All Aspects (Media Experts)

No	Aspect	P1	P2	$\bar{x}$	Category
1	Feasibility of Module Cover Design	3.28	3.28	3.28	Highly Feasible
2	Feasibility of Module Content Design	3.93	3.36	3.64	Highly Feasible
	Overall Expert Average	3.46			Highly Feasible

Source: Calculation results (2024)

Based on the data above, the overall feasibility of the module design was rated at an average score of 3.46, categorized as "highly feasible." Therefore, the STEAM-based mathematics geometry integration module was deemed highly suitable for use.

Table 3.4 Aggregate Scores for All Aspects (Subject Matter Experts)

No	Aspect	P1	P2	P3	$\bar{x}$	Category
1	Content Feasibility	4	3.75	3.91	3.91	Highly Feasible
2	Language Feasibility	4	3.88	3.93	3.93	Highly Feasible
3	Contextual Evaluation	4	4	4	4	Highly Feasible
$\bar{x}$	Average Expert Rating on Content Module				3.94	

Source: Calculation results (2024)

The average score of 3.94 from subject matter experts also indicated that the module was "highly feasible." Consequently, the learning module was concluded to be of excellent quality.

3.2 Module Effectiveness Tests

3.2.1 Normality Test

Table 3.5 Normality Test Results for Module Effectiveness (Improvement in Vocational Values)

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	TEST	Statistic	df	Sig.	Statistic	df	Sig.
SCORE	PRETEST	.143	24	.200*	.959	24	.413
	POST-TEST	.134	24	.200*	.935	24	.125

The Kolmogorov-Smirnov normality test yielded significance values of 0.200 for both the pretest and posttest groups ($p > 0.05$). These results indicate that the data were normally distributed.

3.2.2 Homogeneity Test

The homogeneity test, conducted using Levene's Test for Homogeneity of Variances, indicated a significance value of 0.429 ($p > 0.05$), confirming that the data were homogeneous.

Table 3.6 Homogeneity Test Results for Module Effectiveness

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
SCORE	Based on Mean	.637	1	46	.429
	Based on Median	.681	1	46	.414
	Based on Median and with adjusted df	.681	1	42.11	.414
	Based on trimmed mean	.629	1	46	.432

3.2.3 Paired t-Test

The paired t-test was used to determine whether there was a significant difference between pretest and posttest scores.

Table 3.7 t-Test Results for Pretest and Posttest (Performance Test)

Paired Samples Test

	Paired Difference							
				95% Confidence interval of the Difference				
	Mean	Std.Deviaton	Std Error Mean	Lower	Upper	t	df	Sig (2-tailed)
Pair 1 PRETEST – POSTTEST	-6.333	2.854	0.583	-7.538	-5.128	-10.872	23	0.000

The analysis yielded a significance value of 0.000 ($p < 0.05$), indicating a significant difference in learning outcomes among the students before and after using the learning module. The calculated t-value of 10.872 exceeded the critical t-value ($df = 23$, $\alpha = 0.10$) of 1.71, leading to the conclusion that the module significantly improved vocational values in the students.

3.2.4 N-Gain Analysis

The N-Gain analysis measured the effectiveness of the module in enhancing student learning. The calculation, based on the difference between pretest and posttest scores, was conducted using SPSS.

Table 3.8 N-Gain Descriptive Statistics for Pretest and Posttest (Performance Test)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
N-Gain	24	.33	1.00	.6536	.20143
Valid N (listwise)	24				

The average N-Gain score was 65.36%, with a minimum score of 33% and a maximum score of 100%. According to the N-Gain interpretation table, the average score falls into the "moderately effective" category for achieving student learning mastery.

Table 3.8 N-Gain Score Interpretation

Percentage (%)	Interpretation
<40	Ineffective
40-55	Less Effective
56-75	Quite Effective
>76	Effective

Based on these results, it can be concluded that the STEAM-based module effectively enhances student learning outcomes in vocational values.

3.3 Discussion

The current developments in education require significant changes in teaching methods. With the advancement of technology and information, 21st-century skills such as critical thinking, collaboration, and creativity have become increasingly essential (Silaen et al., 2024). Teachers play a critical role in meeting these demands, and effective teaching methods and media must be developed to create a generation capable of competing in the global era. Developing effective methods and media is also crucial for fostering vocational values among students. The effectiveness of the developed module is closely tied to its objectives, which include improving the quality of learning and addressing classroom challenges. This research aims to nurture vocational values in elementary school students through the integration of mathematics geometry lessons using STEAM-based approaches. Achieving the desired quality and learning outcomes requires the development of teaching materials that enhance the competencies of students (Hendri, 2018).

Through testing the effectiveness of the STEAM-based integrated module, the results indicated a notable improvement in vocational values among students, particularly in psychomotor aspects. Before the intervention, only 16.67% of students demonstrated an adequate understanding and application of vocational values, while the remaining 83.34% had yet to grasp or apply these values. After the intervention, 91.62% of students exhibited

excellent improvement (Grade A), and 8.37% showed good improvement (Grade B). This indicates that using the module significantly enhanced vocational values in elementary school students.

Table 3.9 provides a summary of the improvements in vocational values achieved through the STEAM-based module:

No.	Indicator	Details
1	Logical Thinking	The logical thinking skills of students showed a significant improvement of 54.17%, classified as excellent.
2	Understanding 2D and 3D Images	The ability of students to understand 2D and 3D images increased significantly by 54.17%, classified as excellent.
3	Designing	The ability to design a spatial structure into a building model demonstrated a very good improvement of 66.67%.
4	Innovativeness	The ability of students to innovate showed a significant increase of 50%, categorized as excellent.
5	Discipline/punctuality	The level of discipline of students in completing tasks demonstrated a very good improvement of 58.33%.

These findings align with Irwanto (2020), who emphasized that the specific goals of vocational education are to enhance students intelligence, knowledge, personality, morality, and skills, enabling them to live independently and pursue further education. The implementation of the module significantly improved students understanding and application of vocational values, with positive implications for their futures. These values include essential non-academic skills needed to face career and life challenges.

Developing vocational values in contemporary learning must be complemented by enhancing students cognitive abilities. Education should focus not only on improving thinking skills but also on other abilities, such as communication, creativity, innovation, confidence, emotional regulation, teamwork, good character, and leadership (Nurvitasari et al., 2023).

Creativity is a vital skill that should be nurtured from an early age. At the elementary level, innovative teaching strategies are key to fostering creativity. To support classroom learning, the researchers developed a STEAM-based module integrating mathematics geometry lessons with vocational values. This approach aligns with Lastri (2023), who highlighted that teachers require teaching materials that contribute to efficient and effective student learning.

After using the STEAM-based geometry module, students demonstrated better logical thinking in problem-solving, corroborating findings by Winarti et al. (2018). Problem-solving is a fundamental part of human life, and critical thinking is essential for effective problem-solving.

Additionally, students ability to design creative projects improved as they were given opportunities to express ideas and innovate in creating building models. This aligns with Sari et al. (2015), who stated that the quality of education must be continuously enhanced to foster creativity, including creative thinking skills, attitudes, and actions.

Teaching materials play a significant role for both teachers and students in the learning process. Teachers are instrumental in creating instructional tools (Anisa and Sri, 2024). Following previous research, the systematic and structured STEAM-based mathematics geometry module was implemented. The module was deemed highly feasible, with media experts rating its design at an average score of 3.46, categorized as "very feasible," and subject matter experts giving an average score of 3.94, also categorized as "very feasible." These results affirm that the module supports achieving educational objectives, specifically in fostering vocational values among fifth-grade students at AL-YA'LU Excellent Elementary School in Malang.

CONCLUSION

1. The STEAM-based mathematics geometry integration module designed to promote

vocational values in elementary school students is deemed highly suitable as a teaching material. This conclusion is supported by the feasibility tests conducted through evaluations by media and subject matter experts, with average scores indicating a "highly feasible" criterion.

2. The developed learning module is highly practical and effective in enhancing vocational values among fifth-grade students at AL-YA'LU Excellent Elementary School in Malang.

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