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Implementation of STEM-Integrated Modules and Wasaka Character Values to Improve Learning Outcomes

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Abstract: STEM education, which includes Science, Technology, Engineering and Mathematics, is essential to prepare students with the skills and knowledge required in the modern world. This study aims to evaluate the effectiveness of the implementation of a STEM-integrated module combined with Wasaka character values to enhance student learning outcomes. The Wasaka values, rooted in local culture, include religiousness, resilience, responsibility, and independence, and are integrated into the STEM curriculum to create a holistic educational approach. The research employs a quasi-experimental design with pre-test and post-test assessments 35 students in a field trial phase. Statistical analyses, including paired t-tests and Wilcoxon signed-rank tests, were used to determine the significance of differences in student performance before and after the intervention. The results show a significant improvement in student learning outcomes, with all students demonstrating higher scores in post-tests compared to pre-tests. The integration of STEM and Wasaka character values enhanced academic achievement. This research concludes that the STEM-integrated module with Wasaka values is effective in improving both cognitive and character aspects of students, providing a model for more comprehensive and culturally responsive educational practices.

Keywords: Learning Module; Learning outcomes; STEM

Introduction

STEM education, which includes Science, Technology, Engineering and Mathematics, is essential to prepare students with the skills and knowledge required in the modern world. Research shows that STEM education not only provides a strong foundation in these subjects but is also important in improving the overall quality of education (Wahyuni., 2024 ; Chisom, 2024). By following international standards and integrating various aspects of STEM, students can better prepare themselves for future challenges, which is in line with global trends that favor competencies in these areas. The positive impact of STEM education extends not only to individuals, but also to society as a whole. A positive attitude towards STEM among educators is essential to influence student learning outcomes and support national progress (Aderonke, 2023;Chaya, 2023). The integration of modern technology in STEM education not only improves students' skills but also opens up new career opportunities in the sector (Subasman, 2023). Ensuring equitable access to quality and inclusive STEM education is critical to fostering diversity and innovation, ultimately contributing to scientific progress (Thomas, 2023).

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Character development also plays a fundamental role in education, serving to shape students' values, attitudes and behaviors so that they become individuals of integrity. Research shows the importance of integrating ethical values and virtues in the curriculum to support students' character development. For example, character education programs such as the Living Values Education Program (LVEP) and Islamic-based approaches, as discussed by (Komalasari, 2023 ; Setyawan, 2023), demonstrate how character elements can be included in the curriculum to equip students to face moral challenges and make positive contributions to society.

Character development also plays an important role in the context of STEM education, where the integration of ethical values and social responsibility can enrich learning. One of the characters that can be integrated is the wasaka character (independent, resilient, responsible, religious) (Annisa, 2022). Research (Sudarmin, 2023) on project-based learning with an Ethno-STEM approach shows how values such as environmental stewardship and innovation can be embedded in STEM subjects. The integration of STEM education with character education is an effective approach to develop students holistically, equipping them with technical skills as well as important ethical values. In addition, approaches such as those described by (Feng, 2023; Loof, 2023) suggest that incorporating character principles in STEM education can encourage critical thinking skills, creativity and social responsibility. Frameworks involving design thinking and Arts Integration world-based projects help students not only understand technical concepts but also develop values such as perseverance and collaboration. Other studies, such as those conducted by (Rahmi, 2023; Supriyadi, 2024), underscore the importance of integrating cultural values and religious teachings in character education. With this approach, STEM education not only improves technical competencies but also shapes students' characters with virtues that support success and positive contributions in society. Furthermore, the philosophical framework proposed by Hallström (2023) emphasizes the importance of design in STEM integration and character education, with design thinking enhancing students' problem-solving skills and creativity.

This research aims to evaluate how the implementation of the STEM and Wasaka character integrated module can affect student learning outcomes in elementary schools. By identifying challenges in the implementation of this module, this research also aims to provide recommendations for more effective and comprehensive curriculum development.

Method

In this study, a one-group pre-test post-test design was employed. The research population consisted of all fifth-grade students in elementary schools in Banjarmasin, South Kalimantan. A convenience sampling technique was used, where the sample was selected based on availability and ease of access. The study was conducted with 35 students at SDN Sungai Miai 5 Banjarmasin.

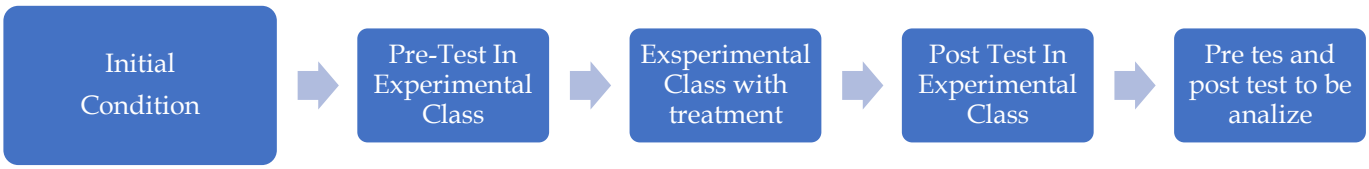

Figure 1. Research Flow

The research instruments used included various tools for comprehensive data collection. First, interviews with teachers and students were conducted to obtain an initial understanding of the learning process. Second, the module was validated by experts in terms of content, language, and design. Third, observation sheets were applied to monitor the activities of teachers and students during the learning process using STEM-integrated modules with Project-Based Learning (PjBL) and Problem-Based Learning (PBL) models. Fourth, teacher and student response questionnaires, as well as student learning outcome evaluation sheets, were also included. Visual documentation was collected to enhance the validity of the research.

Data were collected through various methods such as pre-tests, post-tests, observations, interviews, and document analysis. Data analysis was conducted using descriptive statistics to describe the characteristics of the participants and STEM achievement scores. Additionally, qualitative analysis of data, such as interview transcripts, provided deeper insights into the implementation of the module and students' perceptions.

Resultand Discussion

At the beginning and end of the learning process, the evaluation of students' learning outcomes was

conducted. The students' evaluation scores are presented in Table 1.

Table 1. Students' Learning Outcome Evaluation

No.	Score Range	Pre-test Frequency	Post-test Frequency
1.	0-10	0	0
2.	10-20	8	0
3.	20-30	5	0
4.	30-40	11	0
5.	40-50	9	0
6.	50-60	1	0
7.	60-70	1	0
8.	70-80	0	6
9.	80-90	0	4
10.	90-100	0	25
Total		35	35

The data analysis results for the pre-test and post-test during the field trial involving 35 students demonstrated an improvement in learning outcomes after using the STEM-integrated learning module. Overall, all students showed significant improvement, indicating the effectiveness of the learning module in enhancing students' learning outcomes.

Based on the students' learning outcomes evaluation data from the field trial, a significant change between pre-test and post-test scores was observed. Before the learning process began, the majority of students had relatively low scores, with most students falling within the 30-40 score range. However, after the learning process was completed, students' scores increased dramatically, with most students scoring within the 90-100 range. This change indicates a significant improvement in understanding after the learning process.

One possible reason for the increase in students' scores is the effectiveness of the teaching methods or materials used. When the teaching methods implemented successfully help students better understand the material, this improvement in learning outcomes is a natural result. The increase from low pre-test scores to high post-test scores suggests that students who initially had inadequate understanding significantly improved their comprehension after receiving instruction.

Additionally, the interactive and student-focused teaching methods likely played a key role in achieving these results. Learning methods involving group discussions, project-based learning, or the use of relevant technology may have provided better support to students in understanding difficult concepts. Vygotsky's Constructivism theory supports this idea, emphasizing the importance of active student engagement in the learning process and social interaction as key to better understanding (Suoth, 2022).

Finally, a results-oriented learning approach also contributed to the improvement in students' scores. Skinner's Behaviorism theory suggests that positive reinforcement and feedback during the learning process can strengthen students' understanding and motivate them to achieve better results (Novitasari, 2022). In this context, the high post-test scores may reflect how students were motivated by the feedback they received during the learning process. Thus, this field trial data indicates that effective, interactive, and results-focused teaching methods significantly improved students' learning outcomes.

From all the data obtained, further calculations were made using SPSS 27. The results of the calculations using SPSS 27 for the normality test are presented in Table 2.

Table 2. Normality Test of Learning Outcome Evaluation in the Field Trial Stage

		Unstandardized Residual
N		70
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	10.75832089
Most Extreme Differences	Absolute	.175
	Positive	.111
	Negative	-.175
Test Statistic		.175
Asymp. Sig. (2-tailed)		.000[c]

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.

Based on Table 2, the asymptotic significance (2-tailed) value from the Kolmogorov-Smirnov test shows a value of 0.000 < 0.05, indicating that the data is not normally distributed. The homogeneity test is presented in Table 3.

Table 3. Homogeneity Test of Learning Outcome Evaluation in the Field Trial Stage

Levene Statistic	df1	df2	Sig.
9.349	1	68	.003

Based on Table 3, a significance value of 0.003 < 0.05 was obtained, indicating that the data is heterogeneously distributed or not homogeneous. Because the data distribution is not normal and not homogeneous, a non-parametric test using the Wilcoxon test was employed. The results of the Wilcoxon test, calculated using SPSS 27, to test the difference between pre-test and post-test scores after the treatment are presented in Table 4.

The Wilcoxon Signed Ranks Test was used to determine the difference between pre-test and post-test scores. The test results showed that there was no

decrease in scores from pre-test to post-test (negative ranks = 0), and all students showed an increase in scores (positive ranks = 35). The mean rank of 18 indicates an average increase of 18 points. The statistical results showed a Z value of -5.164 and an asymptotic significance (2-tailed) value of 0.000, which is less than 0.05. This indicates a significant difference between pre-test and post-test scores, meaning that the learning module successfully improved students' learning outcomes.

Table 4. Wilcoxon Test of Students' Learning Outcome Evaluation in the Field Trial

		N	Mean Rank	Sum of Ranks
Post-test - Pre-test	Negative Ranks	0[a]	.00	.00
	Positive Ranks	35[b]	18.00	630.00
	Ties	0[c]		
	Total	35		

a. Post-test<Pre-test
b. Post-test>Pre-test
c. Post-test = Pre-test

	Post-test - Pre-test
Z	-5.164[b]
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Data analysis showed that the use of the implemented learning module significantly improved students' learning outcomes. Despite the data not meeting the assumptions of normality and homogeneity, the non-parametric test ensured that this improvement was real and significant. These results provide evidence that the learning module was effective in enhancing students' learning outcomes, as indicated by the significant increase from pre-test to post-test scores.

The STEM and character integration module demonstrated a positive relationship with the improvement in students' learning outcomes. The implementation of this module not only taught students technical and scientific concepts but also instilled character values such as responsibility, perseverance, and cooperation. The research results showed a significant improvement in students' learning outcomes, as reflected in the comparison of pre-test and post-test scores. This module allowed students to apply their STEM knowledge in a meaningful context while developing the character needed for future success.

The use of STEM and character integration modules has proven effective in improving academic competence and student character. The results of this study are also supported by Agung's research (2022) which developed a science module with a STEM-PjBL model oriented to character education can improve learning outcomes. to improve student character. This increase also reflects the effectiveness of the module in building a foundation of character while improving students' academic competence. This shows that this module is effective for all levels of student ability. Similar results were also found in Hindrasti (2022) previous research that tried to improve students' abilities with modules.

With the STEM approach, students are invited to learn actively through practical projects and activities that are relevant to real life. This not only improves their understanding of the subject matter but also develops positive attitudes such as social responsibility and care for the environment. Research (Voronkin, 2023) on project-based learning with Arduino shows how practical projects strengthen cognitive and technical skills while instilling values such as perseverance and teamwork. Engaging students in real-world projects not only improves technical competence but also fosters motivation and a sense of responsibility. This approach creates synergy between technical knowledge and character development, preparing students for all-round success.

The module also encourages students to think critically and creatively in solving problems, which are important skills in the 21st century. The integration of STEM and character can enhance intellectual skills, but also social abilities, such as practical experiences as described by (Kaspul, 2024; Melita, 2023)involving environmental education activities and learning media development, strengthening students' character development through direct application of moral values and sustainability. The integration between academic learning and character development ensures students not only have the intellectual skills, but also the moral compass and social capabilities essential for the future.

Research shows that combining STEM disciplines with character-building initiatives can create a well-rounded educational environment that supports academic excellence as well as moral development. For example, a study (Ye, 2023) on innovative STEM teacher training emphasizes the importance of educators being able to integrate these two aspects, creating cohesive learning conditions and focusing on both academic and ethical achievement. This integration requires a shared commitment from educators and policy makers to build a curriculum that prioritizes moral values alongside technical knowledge. Some relevant references may provide valuable insights: (Ayeni, 2024) explores the integration of emotional intelligence in STEM education, which can improve students' resilience, focus and interpersonal skills. (Dirgantari, 2023) presents an ethnopedagogy-based character education model that instills superior character while preserving local culture and encouraging nationalist and humanist values.

Based on these findings, it is recommended that education curricula at the primary and secondary levels systematically integrate STEM and character aspects.

Such curriculum development will help students prepare for future challenges with strong technical and ethical skills. In addition, further research is needed to further evaluate the effectiveness of this module in various educational contexts and how its application can be adapted to local needs and student characteristics.

Conclusion

The study demonstrates that the implementation of a STEM-integrated learning module significantly enhances students' learning outcomes. Despite the challenges of non-normal and non-homogeneous data distribution, the use of non-parametric statistical tests confirmed that the observed improvements in students' pre-test to post-test scores were statistically significant. The module improved students' technical knowledge.

The positive correlation between the STEM-integrated module and improved learning outcomes highlights the module's effectiveness in promoting holistic education. This study underscores the importance of integrating technical subjects with character education in order to prepare students for future challenges. The findings suggest that such educational approaches can successfully enhance academic performance, making it a valuable model for curriculum development at primary education levels.

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Author Contributions
For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "Conceptualization, AM, BD, HM, WA contributed to the data collection process, data processing, and article writing. MA, PT contributed to the data processing and article writing

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Conflicts of Interest
The authors declare no conflict of interest.

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