Entrepreneurial BMC Game: Developing High School Students' Numeracy Literacy Mastery

Efa Wahyu Prastyaningtyas[1]✉, Widi Wulansari[2], Elis Irmayanti[1]

DOI: 10.15294/dp.v20i1.24326

[1]Department of Economic Education, Faculty of Economics and Business, Universitas Nusantara PGRI Kediri, Kediri, Indonesia
[2]Department of Teacher Education for Elementary School, Faculty of Teacher Training and Education, Universitas Nusantara PGRI Kediri, Kediri, Indonesia

Abstract

This study aims to test the effectiveness of the Entrepreneurial Business Model Canvas (BMC) Game in improving the numeracy literacy skills of high school students in red-ranked schools in Kediri City. Using a pseudo-experimental method with a one-group pre-test-post-test design on a small-scale trial (20 students of Sultan Agung High School) and a post-test-only design with a non-equivalent group on a large-scale trial (39 students of Al Anwar High School), the research applied a game that integrates entrepreneurial concepts with numeracy literacy. Data analysis using Paired t-test for small scale and independent t-test for large scale showed significant improvement in students' numeracy and literacy skills ($p<0.05$). On a small scale, the average score increased from 77.10 to 79.25, while on a large scale, the experimental group achieved an average of 79.38 compared to 77.00 for the control group. The Entrepreneurial BMC Game is proven effective in helping students develop their numeracy-based financial data analysis, business projection, and decision-making skills through collaborative and contextual learning. It offers an interesting and applicable alternative numeracy learning solution. Pedagogically, the game fosters active student engagement and enhances higher-order thinking by linking abstract numeracy concepts with real-world entrepreneurial contexts.

How to Cite

Prastyaningtyas, E.W., Wulansari, W., & Irmayanti, E.(2025).Entrepreneurial BMC Game: Developing High School Students' Numeracy Literacy Mastery. *Dinamika Pendidikan*, 20 (1), 136-147.

INTRODUCTION

Education in Indonesia currently faces challenges in creating competent young people in various fields, especially in numeracy skills (Damayanti et al., 2023). Numeracy literacy, the ability to understand and use numbers and data-based information in everyday life, is a key skill students require, especially in this digital era (Annisa et al., 2023). However, despite its importance, the mastery of numeracy literacy among students, especially at the senior high school level, is still far from expectations. Many students cannot process data appropriately, solve problems requiring numbers, or use numerical information in real-life contexts (Sinaga et al., 2023).

Senior high school students' low mastery of numeracy literacy can be attributed to conventional learning methods that are still heavily theory-based and lack real-world application (Cardino & Ortega-Dela Cruz, 2020). Many students cannot process numerical data, solve quantitative problems, or apply numeric reasoning in practical contexts (Sinaga et al., 2023). This is mainly due to instructional approaches that fail to spark engagement or demonstrate relevance to daily life. To overcome this, teachers must adopt more interactive and contextual learning models, such as entrepreneurship-based strategies, that enhance students' interest and connect numeracy skills with meaningful experiences (Urhahne & Wijnia, 2023; Newman et al., 2019).

One of the factors causing the low mastery of numerical literacy is learning methods that are still fairly conventional and less interesting for students (Cardino & Ortega-Dela Cruz, 2020). Focusing more on theory without direct application makes students less motivated to explore the material (Urhahne & Wijnia, 2023). So, the teacher's job is to arouse students' interest and motivation by making entrepreneurial learning more interactive (Urhahne & Wijnia, 2023). The goal is to provide an understanding of basic concepts highly relevant to everyday life and good entrepreneurial practices (Newman et al., 2019).

To overcome this problem, a more innovative and interactive approach is needed in the learning process. One method can be using educational games that combine learning elements with game elements (Pratami et al., 2023). Entrepreneurial Business Model Canvas (BMC)-based games offer an excellent opportunity to develop students' numeracy literacy mastery in a fun and applicable way (Prastyaningtyas et al., 2025). Using BMC, students learn about business theory and are involved in data processing, financial analysis, and planning and managing business resources (Hartikainen et al., 2023).

The Business Model Canvas (BMC) is a tool for designing a comprehensive and structured business model. BMC teaches students to consider various important business aspects, such as the value offered, the resources needed, and financial planning (Rizan et al., 2024). In this context, an entrepreneurial BMC-based game is expected to provide a deeper understanding of entrepreneurship while training students' numeracy skills, which in turn can improve their data processing and number-based decision-making skills (Wei et al., 2022).

However, although educational games have been widely used in various disciplines, very few still integrate the development of numeracy literacy thoroughly in the context of entrepreneurship. Most existing games still focus on business theory or math without involving practical skills that require students to use numbers and data in real business decision-making. Therefore, this research focuses on developing an Entrepreneurial BMC Game that teaches entrepreneurial concepts and hones students' numeracy skills in managing number-based information (Prastyaningtyas et al., 2025).

The game is expected to assist high school students in understanding financial planning, cost analysis, and profit projection, all of which require sound numerical data processing (Mhlongo et al., 2023). In addition, the game also aims to improve students' ability to make business decisions that involve

calculations and analysis based on data and numbers (Jääskä et al., 2022). In the process of the game, students will learn to manage and organize business finances practically, which simultaneously strengthens their ability in numeracy and literacy.

The importance of mastering numeracy literacy in students' lives is also related to their readiness to face challenges in the real world (Nityasanti et al., 2025). In the working world, numeracy skills are often used to manage budgets, analyze market trends, and make decisions based on existing data. Therefore, developing numeracy literacy from an early age is very important to prepare students for the challenges of professional life (Kuswanti, 2023). Entrepreneurial BMC-based games can be an effective solution to developing these skills, because through interesting business simulations, students can apply theory and practice at once.

This research is motivated by several high school-level schools in Kediri city that still get red report cards. Based on data from the Kediri City Education Office in 2024. The schools are SMA Sultan Agung and SMA Al Anwar. One of the indicators of schools getting a red report card is still low literacy and numeracy (Imron et al., 2023). This can be seen from the results of preliminary observations conducted by researchers showing that teaching and learning activities carried out in these schools are still conventional, teachers still rarely use learning media that are attractive to students, literacy and numeracy skills are also still less than 20% of students who understand and understand, learning infrastructure facilities are also still lacking support, students will participate in many learning activities in class if they are related to entrepreneurship.

The urgency of this research is to add references for teachers, especially those who teach in red-ranked schools. Using entrepreneurial BMC games, students will be directly involved in planning and designing businesses to help them understand numeracy concepts in relevant contexts. As for students, they get a collaborative learning experience in the form

of small projects to formulate business plans and improve numeracy and literacy themselves.

One of the objectives of this study is to examine the extent to which the Entrepreneurial BMC Game can improve the numeracy skills of high school students. Through this study, we will analyze the changes in students' numeracy literacy skills before and after participating in the game. Using a standardized numeracy literacy test, this study will measure the extent to which the game impacts students' understanding of numerical concepts related to entrepreneurship. The results of this study are expected to significantly contribute to the development of learning methods that are more relevant to the needs of students in the digital era. A well-designed Entrepreneurial BMC Game will help students understand entrepreneurial concepts and hone their numeracy skills. This will positively impact students' understanding of the business world while strengthening data processing skills that are highly needed in various aspects of life.

METHODS

In previous studies, researchers have developed Entrepreneurial BMC games using the 4D model: Define, Design, Develop, and Deploy. However, in its implementation, previous research (Prastyaningtyas et al., 2025) still reached three stages: Define, Design, and Develop. Furthermore, at the Deploy stage, research was conducted using a quasi-experiment with 2 two designs, namely (1) a one-group pre-test Post-test Design and (2) a Post-test-Only Design with a Non-equivalent Group. The first design was used for small-scale trials conducted at SMA Sultan Agung Kediri with 20 students.

The second design was used for large-scale trials at SMA Al Anwar Kediri with 39 students divided into two groups: the experimental group of 21 students and the control group of 18 students. The data collection techniques in this study were tests and observations. Research instruments in the form of

questions consisting of pre-test and post-test, as well as observation, were used to determine the application and improvement of numeracy literacy skills of high school students in the field of entrepreneurship. The instruments, consisting of 20 pretest and posttest questions, were tested for validity and reliability by three experts with the following results.

Table 1. Content Validity Test Results

Item	V (Aiken Value)	Result	Item	V (Aiken Value)	Result
Item 1	0.89	Valid	Item 11	0.78	Valid
Item 2	0.89	Valid	Item 12	0.56	Valid
Item 3	0.67	Valid	Item 13	0.78	Valid
Item 4	0.89	Valid	Item 14	0.56	Valid
Item 5	0.89	Valid	Item 15	0.89	Valid
Item 6	1.00	Valid	Item 16	0.56	Valid
Item 7	0.67	Valid	Item 17	0.67	Valid
Item 8	0.78	Valid	Item 18	0.56	Valid
Item 9	0.78	Valid	Item 19	0.56	Valid
Item 10	0.78	Valid	Item 20	0.78	Valid

Source: Processed Data (2025)

Table 2. Reliability Test Result

Reliability Statistics	
Cronbach's Alpha	N of Items
0.973	20

Source: Processed Data (2025)

Data were analyzed using a paired t-test for small-scale trials, while large-scale trials were analyzed using an independent t-test. This analysis was carried out to compare the results of the pre-test and post-test, and compare the scores of the control and experimental groups, so that it would appear how much influence was given from the application of the BMC Game developed to improve numeracy literacy skills in high school students in the field of entrepreneurship.

RESULT AND DISCUSSION

The developed entrepreneurial BMC game was tested on a small scale using the first design and a large scale using the second design. In the first design, a group was given a pretest to measure their initial ability, then received treatment in the form of the Entrepreneurial BMC Game, and finally underwent a posttest to assess changes in ability. Meanwhile, the second design included two groups, an experimental group and a control group. The experimental group received the Entrepreneurial BMC Game treatment, while the control group received conventional learning. Both groups were given a posttest to compare their numeracy literacy skills. The study involved 59 children from two high schools that received red report cards in Kediri, namely 20 children from SMA Sultan Agung and 39 children from SMA Al Anwar Kediri.

The data collection technique used tests with instruments like pretest and posttest questions. The questions cover eight materials by the Entrepreneurial BMC Game: recognizing the business model canvas, basic numeracy literacy, simple financial analysis, market data analysis, product pricing, competitor analysis, financial projections, and data-based decision making. Data analysis was conducted with a paired t-test and an independent t-test. Before the hypothesis test, the prerequisite analysis test was carried out as a normality test using the Kolmogorov-Smirnov test and a homogeneity test using the Levene test. Indicator grids were developed to assess students' initial numeracy literacy skills.

Results of BMC Game Implementation at the school

Through a systematic approach, the "Entrepreneurial BMC Game" research was implemented to improve high school students' numeracy literacy skills in entrepreneurship. The initial stage of this research involved a

thorough preparation process that began with a needs analysis of students' numeracy literacy skills. This analysis was conducted through direct observation methods and in-depth interview sessions with teachers of relevant subjects. The needs analysis findings then became the foundation for the researcher in developing pretest and posttest instruments specifically designed to measure students' numeracy literacy mastery level in the context of entrepreneurship learning.

One of the main focuses in education is numeracy literacy, which refers to students' ability to understand and apply mathematical concepts and numbers in solving everyday problems. Low numeracy literacy among students in red-ranked schools often becomes an obstacle for them to succeed in education and life in the future. The low numeracy literacy among students is not only because mathematics teaching in Indonesia still uses many traditional methods that rarely involve active interaction or technology, which impacts students' low numeracy skills (Prastyaningtyas et al., 2025).

As part of this preparation stage, researchers focused on developing the Entrepreneurial BMC Game that comprehensively integrates various numeracy literacy components. The development of this game was followed by preparing operational guidelines and various supporting materials intended for the two main parties in the learning process, namely students as research subjects and teachers as learning facilitators.

The research implementation stage began with administering a pretest to document the initial numeracy literacy skills of the students. Next, the students were introduced to the concept of Business Model Canvas and its important relationship with numeracy literacy in the entrepreneurial world. The implementation of the Entrepreneurial BMC Game was carried out in four structured and interrelated learning stages. The first stage introduces students to the game mechanics and the process of forming business groups that form the basis of learning activities.

The second stage focuses on exploring the elements of Value Proposition and Customer Segments, with market data analysis activities to find potential business opportunities. The third stage focuses on the simulation of revenue streams and cost structure, which integrates complex financial calculations. In the fourth stage, students combine all BMC elements in a comprehensive business scenario that evaluates numeracy literacy skills comprehensively. Throughout the implementation of the game, the researcher conducted structured observations to monitor the development of students' skills, and ended with a posttest to assess the improvement of numeracy literacy skills.

The implementation strategy of the Entrepreneurial BMC Game is constructed to optimize active participation and collaboration-based learning. Students collaborate in small groups of 4-5 members acting as an entrepreneurial team, developing business concepts and completing BMC elements with attention to numeracy aspects. The game is equipped with challenge cards that contain numerical problems based on actual data, giving students experience in dealing with situations that require quantitative analysis skills. The challenges presented include calculating revenue projections based on market segmentation, analyzing business feasibility using the Break-Even Point method, making investment decisions based on data analysis, and evaluating the comparison of various alternative business strategies with quantitative considerations.

The research evaluation system was designed holistically, covering process and outcome assessment. Process assessment is implemented through an observation rubric that specifically measures the expression of numeracy literacy skills during game activities. Outcome assessment was achieved through comparative analysis of pretest and posttest scores, illustrating the dynamics of numeracy literacy mastery levels. Qualitative evaluation was conducted through student reflection sessions and focus group interviews to complement the quantitative data, providing

an in-depth understanding of perceptions and learning experiences. Analysis of students' BMC products was also carried out with an emphasis on the numeracy accuracy aspects contained in the products.

The researcher conducted a results analysis and follow-up in the final implementation stage. The data set was statistically analyzed to measure the significance of changes in students' numeracy literacy skills. The researcher also identified the BMC elements most influential in developing specific aspects of numeracy literacy. Based on the research findings, a BMC game implementation model was developed as a theoretical and practical contribution. Finally, the researcher formulated strategic recommendations regarding integrating this game into the entrepreneurship curriculum at the high school level, ensuring the sustainability and scalability of the research results in a broader scope of education.

Implementation of BMC Game on Small-Scale Trial

Analysis Prerequisite Test

The prerequisite test of the analysis includes normality and homogeneity tests for pretest and posttest scores, to determine whether the sample data is feasible to test the hypothesis with parametric statistics, namely the Paired t-test. The following are the results of the assumption test of the pretest and posttest values with a sample of 20 children from class X SMA Sultan Agung Kediri. Based on Table 3, it can be concluded that the sample taken fulfills the assumption test, so further hypothesis testing can be carried out.

Hypothesis Testing

Hypothesis testing is done to see if there is a difference in pretest and posttest scores on students' numeracy literacy skills after applying the BMC Game. The following hypothesis test results are presented in Table 4. According to the table, it can be seen that the significance value is 0,0001, so it can be interpreted that the significance value is less than the specified alpha value of 0.05. The conclusion is that Ho is rejected and Ha is accepted.

The results of Table 5 show that the average posttest score is higher than the pretest score for numeracy literacy skills in students. Based on the results of hypothesis testing, it can be concluded that there is a difference in pretest and posttest scores for numeracy literacy skills in students after using the BMC

Table 3. Pretest and Posttest Normality and Homogeneity Test Results

Value	Normality		Homogeneity		Hypothesis
	Value	Sig.	Value	Sig.	
Pretest	1.163	0.134	2.737	0.067	H$_0$ diterima *(sig > 0.05)*
Posttest	0.707	0.700	1.008	0.416	

Source: Processed Data (2025)

Table 4. Hypothesis Test Results with Paired t-test

	Paired Samples Test							
	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 Pretest - Posttest	-2.150	1.927	.431	-3.052	-1.248	-4.990	19	.000

Source: Processed data (2025)

Table 5. Descriptive Statistics Results

		Paired Samples Statistics			
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	77.10	20	1.252	.280
	Posttest	79.25	20	1.713	.383

Source: Processed data (2025)

Game, and numeracy literacy skills increase. Thus, implementing BMC Game on Numeracy and literacy skills in students can be interpreted to provide positive and significant results.

Implementation of BMC Game on Large-Scale Trial

Analysis Prerequisite Test

The prerequisite test of the analysis includes normality and homogeneity tests for the posttest values of the control and experimental groups to determine whether the sample data is feasible to test the hypothesis with parametric statistics, namely the independent t-test. The following are the results of the assumption test of the posttest values of the control group with a sample of 18 XI grade students at SMA Al Anwar Kediri and an experiment with a sample of 21 XI grade students at SMA Sultan Agung Kediri. Based on Table 6, it can be concluded that the sample taken fulfills the assumption test, so further hypothesis testing can be carried out.

Hypothesis Testing

Hypothesis testing was conducted to see if there were differences in the posttest scores of the control and experimental groups on numeracy literacy skills in students after applying

Table 6. Normality and Homogeneity Test Results of Control and Experiment

Value	Normality		Homogeneity		Hyphotesis
	Value	Sig.	Nilai	Sig.	
Control & Experiment	0.857	0.454	3.675	0.063	H_0 accepted (*Sig > 0.05*)

Source: Processed data (2025)

Table 7. Hypothesis Test Results with Independent t-test

		Independent Samples Test							
		Levene's Test for Equality of Variances		t-test for Equality of Means					
								95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Value	Equal variances assumed	3.675	.063	-5.074	37	.000	-2.381	.469	-3.332	-1.430
	Equal variances not assumed.			-5.249	34.231	.000	-2.381	.454	-3.302	-1.459

Source: Processed data (2025)

Table 8. Descriptive Statistics Results

	Group Statistics				
	Group	N	Mean	Std. Deviation	Std. Error Mean
Value	Control	18	77.00	1.085	.256
	Experiment	21	79.38	1.717	.375

Source: Processed data (2025)

the BMC Game. The following hypothesis test results are presented in Table 7. If you see the results of the Levene test, the assumption of equal variances is selected. Based on the table, it can be seen that the sig value is 0.0001, so it can be interpreted that the sig value is less than the specified alpha value of 0.05. The conclusion is that Ho is rejected and Ha is accepted.

The results of Table 8 show that the average numeracy literacy skills in the experimental group are higher than those in the control group. Based on the results of hypothesis testing, it can be concluded that there is a difference in numeracy literacy skills in the control group and experimental group after using the BMC Game, and numeracy literacy skills in students are increasing. Thus, it can be interpreted that implementing BMC Game on numeracy literacy skills in students provides positive and significant results.

Implementing the Entrepreneurial BMC Game in the context of entrepreneurship education at the high school level has shown significant results in developing students' numeracy literacy skills. After following the game-based learning series, the pretest and posttest data analysis results indicate a substantial improvement in students' numeracy skills. This finding reinforces recent research results from (Kiili et al., 2018); (Joseph Kafui Letsa, Agbozo Gabina, & Mark Andivi, 2023), which demonstrated the effectiveness of a game-based approach in improving applied mathematics skills in senior secondary students, with an emphasis on contextual relevance that motivates active student engagement.

Regarding numeracy literacy development, the Revenue Streams and Cost Structure components of BMC proved to make the most significant contribution to improving students' quantitative analysis skills. When working on this component, students engage in complex activities such as calculating revenue projections, analyzing cost structures, and calculating break-even points that exercise various aspects of numeracy literacy. This observation correlates with the results of longitudinal studies conducted by Mukuka et al. (2023) and Schoenherr et al. (2024) on the development of numeracy skills in the context of entrepreneurship learning, which emphasize the importance of the application of mathematical concepts in real situations to enhance knowledge transfer capabilities.

The collaborative learning dynamic in implementing the Entrepreneurial BMC Game is an important catalyst in developing students' numeracy literacy. Small groups of 4-5 students showed synergy in overcoming numeracy challenges, as seen in their ability to solve complex problems that required data analysis. These findings support the theoretical framework of social learning developed in a recent study by Jääskä and Aaltonen (2022), which examines how the co-creation process in game-based learning supports the development of higher-order cognitive abilities, including numeracy literacy.

Significant changes were also seen in students' attitudes towards numeracy literacy. Qualitative data from student reflections and focus group interviews revealed a transformation in perceptions of mathematics from an abstract subject to a valuable tool for business problem solving. This phenomenon is in line with the findings of a study (Flint et al., 2019) that examined mathematical identity development in adolescents and the importance

of contextualizing mathematics learning to change negative perceptions and attitudes.

The numeracy-based challenge cards in the game proved effective in improving data analysis and interpretation skills. Students showed significant progress in reading graphs, analyzing trends, and making data-based predictions, which are essential to modern numeracy literacy. These findings reinforce research (Fielding et al., 2025) that identifies the importance of developing data visualization skills as a core component of numeracy literacy in the era of big data and artificial intelligence.

Comparative analysis of pretest and posttest results showed that the most significant improvement occurred in the numeracy literacy dimension related to quantitative data-based decision-making. Students demonstrated better ability in evaluating business alternatives based on numerical analysis, such as comparison of potential profits and investment risks. This improvement aligns with the contemporary numeracy literacy framework that Bakker et al. (2023) proposed, which emphasizes the importance of quantitative reasoning in decision-making as an essential skill for success in the digital economy.

Technology integration in the Entrepreneurial BMC Game is important in improving the effectiveness of numeracy literacy learning. Using digital spreadsheets and simple data visualization applications in the game helps students overcome technical barriers in complex calculations, allowing them to focus on the conceptual aspects of numeracy literacy. These findings reinforce the results of research (Cevikbas et al., 2023) on the role of technology in mediating mathematics learning and numeracy literacy development in the digital era.

The learning model developed through this research offers significant contributions to entrepreneurship pedagogy and mathematics education. The model adopts the game-based learning design principles put forward in a recent meta-analysis study by Chiotaki et al. (2023), which identified key elements such as instant feedback, adaptive difficulty, and con-

textualization as critical factors in the success of educational games.

In the context of national education policy, the results of this study support efforts to develop 21st-century competencies, especially numeracy literacy, as emphasized in Merdeka Belajar policy (Zamjani et al., 2024). This approach also aligns with recommendations from the OECD study (2023) on developing functional mathematics skills for work readiness in the digital economy era. Pedagogical implications of this study include the need to reconceptualize mathematics learning at the upper secondary level, with greater emphasis on contextual applications and problem-based learning. As Hillmayr et al. (2020) argued in a recent report on global education trends, mathematics learning needs to evolve from focusing on procedural content to developing the capacity to apply mathematical concepts in complex real-world contexts.

Implementing the Entrepreneurial BMC Game also faces several practical challenges that need to be addressed, including teacher professional development and adjustments to accommodate the diversity of student abilities. These challenges are consistent with observations (Leal Filho et al., 2018) about the need for systemic transformation in education to support the effective implementation of innovative learning approaches.

This research provides empirical evidence on the effectiveness of the Entrepreneurial BMC Game as a pedagogical tool to develop high school students' numeracy literacy skills in the context of entrepreneurship learning. The developed model offers an implementation framework that educators can adopt to integrate numeracy literacy development in the entrepreneurship curriculum, supporting students' preparation for success in an increasingly complex and dynamic knowledge-based economy.

The Entrepreneurial BMC Game effectively enhances students' numeracy literacy by integrating mathematical reasoning into real business contexts. Students showed improved skills in financial analysis, data interpretation,

and quantitative decision-making, alongside increased engagement and collaboration. This model reconceptualizes numeracy as a practical, contextual skill, supporting 21st-century competencies. While results are promising, future work should address implementation challenges and ensure teacher readiness. Overall, the BMC Game offers a relevant, innovative approach to strengthening numeracy in entrepreneurship education.

CONCLUSION

The Entrepreneurial BMC (Business Model Canvas) Game is proven effective in improving the numeracy literacy skills of high school students. This research shows that a game-based learning approach can bridge abstract concepts of entrepreneurship with practical applications of numeracy skills. The results indicated a significant improvement in students' ability to analyze financial data, make business projections, and make decisions based on numerical information. Students who participated in the game demonstrated a more comprehensive understanding of economic concepts and a better ability to apply mathematical skills to real business contexts. The Entrepreneurial BMC game supports the development of numeracy literacy and fosters students' critical thinking, collaboration, and creativity skills. This learning model successfully creates a learning environment that is more engaging and relevant to students' needs in the digital era. This conclusion emphasizes the importance of integrating innovative learning methods, such as educational games, into the education curriculum to prepare students for future economic challenges and encourage early development of entrepreneurial skills.

However, this study has several limitations that should be noted. The research was conducted with a limited sample size from selected high schools in a specific regional context, which may affect the generalizability of the findings. Additionally, the effectiveness of the Entrepreneurial BMC Game was influenced by the level of teacher involvement and

their familiarity with the game-based learning model. Future studies should involve a more diverse and larger student population across different regions and provide comprehensive teacher training to ensure consistent implementation. It is also recommended that the game be further developed to include adaptive difficulty levels and integration with digital platforms, allowing for broader access and personalization of learning experiences.

REFERENCES

Annisa, A. S., Maftukhah, L., Saniyah, S. M., & … (2023). Study Literature: The Influence of STEAM Learning on Students' Literacy-Numeracy Ability. *PRISMA, Prosiding …,* 6, 31–35. https://journal.unnes.ac.id/sju/index.php/prisma/article/download/66489/23753

Bakker, A., Cai, J., & Zenger, L. (2023). Future themes of mathematics education research: an international survey before and during the pandemic. *Educacion Matematica,* 35(2), 9–46. https://doi.org/10.24844/EM3502.01

Cardino, J. M., & Ortega-Dela Cruz, R. A. (2020). Understanding of learning styles and teaching strategies towards improving the teaching and learning of mathematics. *Lumat*, 8(1), 19–43. https://doi.org/10.31129/LUMAT.8.1.1348

Cevikbas, M., Greefrath, G., & Siller, H. S. (2023). Advantages and challenges of using digital technologies in mathematical modelling education – a descriptive systematic literature review. *Frontiers in Education,* 8(April), 1–17. https://doi.org/10.3389/feduc.2023.1142556

Chiotaki, D., Poulopoulos, V., & Karpouzis, K. (2023). Adaptive game-based learning in education: a systematic review. *Frontiers in Computer Science*, 5(2016). https://doi.org/10.3389/fcomp.2023.1062350

Damayanti, F., Vivien, H., Situmorang, M., Trianung, T., Management, E., & Vivien Management, H. (2023). The problem of education in Indonesia is the independent

curriculum, and the solution is. *Scholar : Educational Scientific Journal Media,* 13(5), 917–924.

Fielding, J., Makar, K., & Ben-Zvi, D. (2025). Developing students' reasoning with data and data-ing. *ZDM - Mathematics Education,* 57(1), 1–18. https://doi.org/10.1007/s11858-025-01671-6

Flint, T. K., Sheppard, P., & Tackie, N. A. (2019). "How You Like Me Now?": Exploring Teacher Perceptions of Urban Middle Schoolers' Mathematical Abilities and Identities. *Education and Urban Society,* 51(8), 1029–1050. https://doi.org/10.1177/0013124518785017

Hartikainen, H., Ventä-Olkkonen, L., Kinnula, M., & Iivari, N. (2023). "We were proud of our idea": How teens and teachers gained value in an entrepreneurship and making project. *International Journal of Child-Computer Interaction,* 35, 100552. https://doi.org/10.1016/j.ijcci.2022.100552

Hillmayr, D., Ziernwald, L., Reinhold, F., Hofer, S. I., & Reiss, K. M. (2020). The potential of digital tools to enhance mathematics and science learning in secondary schools: A context-specific meta-analysis. *Computers and Education*, 153(September 2018), 103897. https://doi.org/10.1016/j.compedu.2020.103897

Imron, I., Pramono, S. E., Rusilowati, A., & Sulhadi, S. (2023). Program Literasi dan Numerasi dalam Perspektif Pendidikan Guru Penggerak. *Prosiding Seminar Nasional Pascasarjana (PROSNAMPAS),* 6(1), 1131–1139.

Jääskä, E., & Aaltonen, K. (2022). Teachers' experiences of using game-based learning methods in project management higher education. *Project Leadership and Society,* 3(January). https://doi.org/10.1016/j.plas.2022.100041

Jääskä, E., Lehtinen, J., Kujala, J., & Kauppila, O. (2022). Game-based learning and students' motivation in project management education. *Project Leadership and Society,* 3(July). https://doi.org/10.1016/j.plas.2022.100055

Joseph Kafui LetsaAgbozo Gabina, S., & Mark Andivi, D. (2023). the Effects of Game- Based Mathematics Learning on Pupils ' Academic Performance in Junior High School University of Business and Integrated Development Studies, Department of Business University of Business and Integrated Development Studies, Office of. 7672, 86–97. https://doi.org/10.5281/zenodo.10147226

Kiili, K., Moeller, K., & Ninaus, M. (2018). Evaluating the effectiveness of a game-based rational number training - In-game metrics as learning indicators. *Computers and Education,* 120(February), 13–28. https://doi.org/10.1016/j.compedu.2018.01.012

Kuswanti, H. (2023). Strategy to Improve Students' Literacy and Numeracy Abilities. *Journal Scientia*, 12(4), 2023–2025. http://infor.seaninstitute.org/index.php

Leal Filho, W., Raath, S., Lazzarini, B., Vargas, V. R., de Souza, L., Anholon, R., Quelhas, O. L. G., Haddad, R., Klavins, M., & Orlovic, V. L. (2018). The role of transformation in learning and education for sustainability. *Journal of Cleaner Production,* 199, 286–295. https://doi.org/10.1016/j.jclepro.2018.07.017

Mhlongo, S., Mbatha, K., Ramatsetse, B., & Dlamini, R. (2023). Challenges, opportunities, and prospects of adopting and using smart digital technologies in learning environments: An iterative review. *Heliyon*, 9(6), e16348. https://doi.org/10.1016/j.heliyon.2023.e16348

Mukuka, A., Balimuttajjo, S., & Mutarutinya, V. (2023). Teachers' efforts towards the development of students' mathematical reasoning skills. *Heliyon*, 9(4), e14789. https://doi.org/10.1016/j.heliyon.2023.e14789

Newman, A., Obschonka, M., Schwarz, S., Cohen, M., & Nielsen, I. (2019). Entrepreneurial self-efficacy: A systematic review of the literature on its theoretical foundations, measurement, antecedents, and outcomes, and an agenda for future research. *Journal of Vocational Behavior,* 110(May 2018), 403–419. https://doi.org/10.1016/j.jvb.2018.05.012

Nityasanti, N., Laila, A., Saida, A., Hanafi, M., & Yasin, M. (2025). 21st Century Learning : A Research Analysis of Numeracy Literacy Trends among Students. 6(1), 264–277.

Prastyaningtyas, E. W., Wulansari, W., & Arifin, Z. (2025). Development of an Entrepreneurial BMC (Business Model Canvas) Game to Improve Numeracy Literacy of High School Students. 12(March), 263–272.

Pratami, I. G. A. P. S., Nitiasih, P. K., & Budiarta, L. G. R. (2023). Development of Educational Games as Learning Media for English Learning for Primary Students. *Language Circle: Journal of Language and Literature,* 17(2), 317–324. https://doi.org/10.15294/lc.v17i2.43129

Rizan, M., Sumastuti, E., Prabowo, H., Kresnamurti, A., & Chalida Hanoum, F. (2024). The Role of Business Model Canvas (Bmc) in Digital Entrepreneurship on Students' Interest in Indonesia. *JRMSI - Jurnal Riset Manajemen Sains Indonesia,* 15(01), 109–124. https://doi.org/10.21009/jrmsi.015.1.10

Schoenherr, J., Strohmaier, A. R., & Schukajlow, S. (2024). Learning with visualizations helps: A meta-analysis of visualization interventions in mathematics education. *Educational Research Review,* 45(September), 100639. https://linkinghub.elsevier.com/retrieve/pii/S1747938X24000484

Sinaga, B., Sitorus, J., & Situmeang, T. (2023). The influence of students' problem-solving understanding and results of students' mathematics learning. *Frontiers in Education,* 8(February), 1–9. https://doi.org/10.3389/feduc.2023.1088556

Urhahne, D., & Wijnia, L. (2023). Theories of Motivation in Education: an Integrative Framework. *In Educational Psychology Review* (Vol. 35, Issue 2). Springer US. https://doi.org/10.1007/s10648-023-09767-9

Wei, C. L., Wang, Y. M., Lin, H. H., Wang, Y. S., & Huang, J. L. (2022). Developing and validating a business simulation system's success model in the context of management education. *International Journal of Management Education*, 20(2), 100634. https://doi.org/10.1016/j.ijme.2022.100634

Zamjani, I., Solihin, L., Nuraini, F., Azizah, S. N., & Rachmat, H. (2024). Implementasi Kurikulum Merdeka dan Peningkatan Kemampuan Literasi dan Numerasi Peserta Didik. In Kemendikbudristek.