2025, Retos, 62, 304-309

Enhancing students reflective thinking through outdoor play and game-based contextual learning

Mejorar el pensamiento reflexivo de los estudiantes a través del juego al aire libre y el aprendizaje contextual basado en juegos

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Abstract. Integrating cognitive, affective, physical, and social aspects of learning helps introduce new ideas and consolidate existing thinking. Games and play can enhance reflective thinking skills in mathematics education. Games in mathematics teaching contribute to cognitive development and provide dynamic strategies for learning. Reflective thinking is one of the essential skills that mathematics students must possess. One method to foster reflective thinking is by applying outdoor contextual learning activities. This study aims to determine reflective thinking and the factors influencing through play and games-based contextual learning. This research method is descriptive and quantitative, with subjects of as many as 231 mathematics students determined based on a purposive sampling technique. The instrument used to collect data was the reflective thinking instrument developed by Kember. Data analysis was carried out using SEM modeling assisted by SmartPLS. Based on the data analysis results, it is known that understanding is the most influential indicator of reflective thinking, with a path coefficient value of 0.404 and a t-statistic > t-table of 19.430 > 1.653. Meanwhile, habitual action is the indicator with the lowest influence, with a path coefficient value of 0.129 and t-statistic > t-table of 3.818 > 1.653. In addition, critical reflection and reflection have a significant effect based on the path coefficient values of 0.330 and 0.381, respectively. This shows that the four indicators significantly influence the reflective thinking of mathematics teacher students.
Keywords: play and game, contextual learning, reflective thinking

Resumen. La integración de los aspectos cognitivos, afectivos, físicos y sociales del aprendizaje ayuda a introducir nuevas ideas y consolidar el pensamiento existente. Los juegos y el juego pueden mejorar las habilidades de pensamiento reflexivo en la educación matemática. Los juegos en la enseñanza de las matemáticas contribuyen al desarrollo cognitivo y proporcionan estrategias dinámicas para el aprendizaje. El pensamiento reflexivo es una de las habilidades esenciales que deben poseer los estudiantes de matemáticas. Un método para fomentar el pensamiento reflexivo es mediante la aplicación de actividades de aprendizaje contextual al aire libre. Este estudio tiene como objetivo determinar el pensamiento reflexivo y los factores que influyen a través del juego y el aprendizaje contextual basado en juegos. Este método de investigación es descriptivo y cuantitativo, con sujetos de hasta 231 estudiantes de matemáticas determinados con base en una técnica de muestreo intencional. El instrumento utilizado para la recolección de datos fue el instrumento de pensamiento reflexivo desarrollado por Kember. El análisis de datos se llevó a cabo mediante modelado SEM asistido por SmartPLS. Con base en los resultados del análisis de datos, se sabe que la comprensión es el indicador más influyente del pensamiento reflexivo, con un valor de coeficiente de trayectoria de 0,404 y un estadístico t > tabla t de 19,430 > 1,653. Mientras tanto, la acción habitual es el indicador con menor influencia, con un valor de coeficiente de trayectoria de 0,129 y estadístico t > tabla t de 3,818 > 1,653. Además, la reflexión crítica y la reflexión tienen un efecto significativo según los valores del coeficiente de trayectoria de 0,330 y 0,381, respectivamente. Esto muestra que los cuatro indicadores influyen significativamente en el pensamiento reflexivo de los estudiantes de profesorado de matemáticas.
Palabras clave: juego y juegos, aprendizaje contextual, pensamiento reflexivo

Fecha recepción: 13-08-24. Fecha de aceptación: 12-10-24
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Introduction

Mathematics is one of the more complex sciences. Studying mathematics requires critical thinking to comprehend and apply concepts effectively when solving various mathematical problems. Mathematical problems encountered are often not immediately solvable. Therefore, it is necessary to have the ability to think and find the right way to solve the problem. The thinking activities or processes undertaken so that a person can solve a mathematical problem have a relationship with the ability to remember and recognize the relationship between mathematical concepts, realize the existence of cause-and-effect relationships, analogical relationships, or differences, which can then bring up original ideas as well as being fluent and flexible in making decisions or conclusions quickly and accurately (Orhan & Ataman, 2024; Vlašić et al., 2024). Learning activities that prioritize the learning process will undoubtedly introduce various thinking activities at different levels and forms. Deliberate and thorough thinking should be the foundation of the problem-solving process from the outset. In this context, completeness implies that individuals must undergo the process, receive training, and utilize their current skills to comprehend and excel in their learning and actions(Hammad & Aberash, 2024). One of the higher-order thinking skills is reflective thinking. Reflective thinking is a thinking activity that can make students try to connect the knowledge they have gained to solve new problems related to their old knowledge. Reflective thinking can be described as information or data used to respond, comes from within, can explain what has been done, realizes the mistakes made, and corrects and communicates ideas with symbols or images rather than with direct objects. Reflective thinking connects the knowledge obtained with old expertise so that a conclusion can be obtained to solve new problems. So, the ability to think is very appropriate for solving math problems (Hamzah et al., 2024; Kholid, Santosa, et al., 2024). Reflective thinking is a series of directed and precise activities in which individuals analyze, evaluate, motivate, gain deep meaning, and use appropriate learning strategies. Reflective thinking is important for teachers and students. Reflective thinking is a cognitive process that involves analyzing one's thoughts, actions, and experiences to gain a deeper understanding and improve future performance (Jiménez-Maldonado et al., 2018; Rodgers, 2002). Preschool preservice teachers develop existing knowledge about reflective thinking, and it has been determined that they have changed and reflective thinking levels have moved from the technical level to a higher level, which is contextual and critical (Firat & Dinçer, 2024; Tiainen et al., 2024). The ability to think reflectively is strongly influenced by mathematics teacher education. Reflective thinking is an important competency that prospective teachers must possess, especially when faced with the intricacies of classroom teaching (Ni et al., 2024; Warifdah & Kholid, 2024). Reflective thinking is beneficial in mathematics education because it allows prospective teachers and educators to assess and improve their teaching methods, thus enhancing the quality of student learning (Fauzan & Arnawa, 2020; Liline et al., 2024). To find out how much students' reflective thinking ability is, then an educator must conduct a series of activities that can make students show students' reflective thinking ability. One of these activities is solving math problems, including problems in everyday life.

Problems in everyday life can be learned through contextual learning. Students must often be taught problem-solving skills so that they are accustomed to solving every problem in their daily lives. Contextual learning emphasizes higher-level thinking, cross-disciplinary knowledge transfer, as well as collecting, analyzing, and synthesizing information and data from various sources and views (Hasanah & Retnawati, 2022; Laurens et al., 2018; Ningrum & Murti, 2023; Saritepeci & Yildiz Durak, 2024). Collaborative design of outdoor mathematical activities, focusing on specific mathematical content, can offer alternative ways to motivate children's learning and approach encourages active student participation, connecting mathematics to real-life experiences (Daher & Baya'a, 2012; Nilsson et al., 2009; Priyadi & Yumiati, 2021; Selvianiresa & Prabawanto, 2017). Contextual Learning has significantly improved critical thinking skills (Bustami et al., 2018; Thamrin et al., 2024; Toheri et al., 2020). The contextual learning model aims to motivate students to understand the meaning of the subject matter they learn by relating the material to the context of their daily lives so that students have knowledge or skills that can be applied reflectively to other problems (Laurens et al., 2018; Raub et al., 2015; Samo, 2019; Samo & Kartasasmita, 2018). This study aims to determine the factors influencing reflective thinking skills based on contextual learning.

Methods

Design

This research is descriptive quantitative research. Descriptive quantitative research aims to explain the facts or characteristics of certain populations or certain fields factually and carefully systematically. The data collection instrument used a questionnaire to determine reflective thinking skills. The questionnaire was adapted from the reflective thinking questionnaire developed by Kember (Kember et al., 2000). Before completing the questionnaire, participants participated in contextual learning designed to stimulate reflective thinking.

Participants

The population in this study was Mathematics Education students at one of the universities. The sampling technique used was purposive sampling, and 231 mathematics education students were selected. Participants in this study have taken lectures ranging from the second to the fourth year, with some participants already having teaching experience.

Data Analysis

Data analysis was conducted using Microsoft Excel and SmartPLS. SmartPLS was used to analyze the complex relationships between variables in the study. PLS-SEM, coupled with the bootstrapping method, was used to examine the interactions between factors influencing reflective thinking thoroughly.

Result and Discussion

Before filling out the questionnaire related to reflective thinking, students fill in their data, which is used to find out how long they have studied in college and what their teaching experience is. Based on the questionnaire results, 63% of the research participants have teaching experience, and most are final-year university students, or as much as 40%. This data is needed to corroborate the factors influencing reflective thinking. Teaching experiences and study duration are shown in Figure 1 and Figure 2.

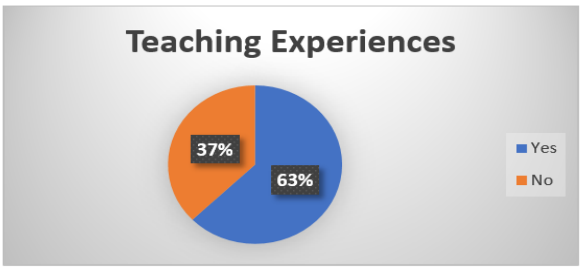

Figure 1. Teaching experiment

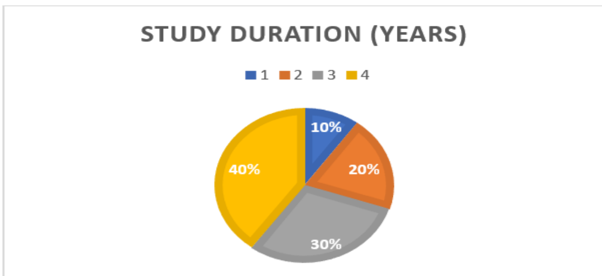

Figure 2. Study duration

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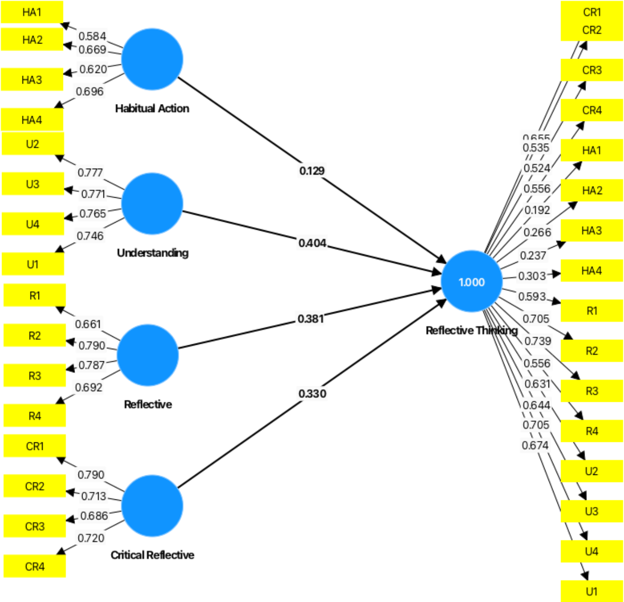

Figure 3. SEM modeling of factors affecting reflective thinking

Measurement Model (Outer Mode)

The test results in the table below show that all outer loading indicator constructs have a loading value> 0.5 and have a t statistic value greater than the t table (> 1.657), so it can be concluded that this measurement meets convergent validity. The results of the calculation of convergent validity can be seen in Table 1.

The discriminant validity results show the root square of the average variance extracted (AVE) value is greater than 0.5. The reliability test results are reliable because the composite reliability value (rho_c) is above 0.7. It can be interpreted that this model has predictive relevance, so it can be said that the model is feasible to estimate.

The results of hypothesis testing are presented in Table 3. By comparing the calculated t value with the t table value, if the calculated t value is greater than the t table value, the relationship between the variables is significant and can be analyzed further. With 231 data, the t table value (=5%) is 1.653, and the t table value (=10%) is 1.285.

Table 1.
Outer loadings result

Dimension	Original sample	T -statistics	Description
CR1	0,745	19,647	reliable
CR2	0,673	11,559	reliable
CR3	0,773	18,166	reliable
CR4	0,706	15,216	reliable
HA1	0,543	3,063	reliable
HA2	0,580	3,555	reliable
HA3	0,611	4,052	reliable
HA4	0,783	6,676	reliable
R1	0,633	10,772	reliable
R2	0,844	51,668	reliable
R3	0,760	20,356	reliable
R4	0,673	12,531	reliable
U2	0,752	16,498	reliable
U3	0,759	22,121	reliable
U4	0,825	48,320	reliable
U1	0,702	14,425	reliable

Table 2.
Construct Reliability and Validity

Indicators	Cronbach's alpha	Composite reliability (rho_c)	Average variance extracted (AVE)
Critical Reflective	0,705	0,818	0,531
Habitual Action	0,733	0,738	0,524
Reflective	0,714	0,823	0,540
Reflective Thinking	0,839	0,869	0,514
Understanding	0,764	0,849	0,585

Table 3.
Hypothesis testing results

Indicators	Path coefficients	T statistics	Description
Critical Reflective -> Reflective Thinking	0,330	15,026*	0,000
Habitual Action -> Reflective Thinking	0,129	3,818*	0,000
Reflective -> Reflective Thinking	0,381	18,058*	0,000
Understanding -> Reflective Thinking	0,404	19,430*	0,000

* significant at the 5% level, the t table value at the 5% level = 1.653
** significant at the 10% level, the t table value at the 10% level = 1.285

Based on the table, it can be seen that the three paths show a significant effect. The interpretation can be explained as follows:

a. Critical Reflective has a positive and significant influence on Reflective Thinking with a CR value (t statistic > t table (15.026 > 1.653) and a path coefficient of 0.330, this coefficient indicates that the better critical reflective will increase Reflective Thinking.

b. Habitual action has a positive and significant effect on Reflective Thinking with a CR value (t statistic> t table (3.818 > 1.653) and a path coefficient of 0.129, and this coefficient indicates that the better the habitual action will increase Reflective Thinking.

c. Reflective has a positive and significant effect on Reflective Thinking with a CR value (t statistic > t table (18.058 > 1.653) and a path coefficient of 0.381, and this coefficient indicates that the better Reflective will increase reflective thinking.

d. Understanding has a positive and significant effect on Reflective Thinking with a CR value (t statistic > t table (19.430 > 1.653) and a path coefficient of 0.404; this coefficient indicates that better Understanding will increase Reflective thinking.

The results of data analysis show that the four factors, namely critical reflective, habitual action, understanding, reflective and understanding have a significant influence on the reflective thinking of mathematics teachers. Decisional self-esteem, decision-making, problem-solving, and creative thinking were positively correlated to reflective thinking. Understanding is the most significant factor in influencing reflective thinking (Ceylan, 2024; Ni et al., 2024; Orhan & Ataman, 2024)

Understanding has a positive and significant effect on Reflective Thinking with a CR value (t statistic > t table

(19.430 > 1.653) and a path coefficient of 0.404; this coefficient indicates that better Understanding will increase Reflective thinking.

Reflection is essential to stimulate and enhance problem-solving, complex thinking, and decision-making skills. Reflective thinking skills are one of the factors that influence students' academic performance. Based on the analysis result, reflective has a positive and significant effect on reflective Thinking with a CR value (t statistic > t table (18.058 > 1.653) and a path coefficient of 0.381, this coefficient indicates that the better reflective will increase reflective thinking.

Critical reflective thinking is when individuals examine their presuppositions and consider previously unreflective aspects of their understanding, leading to personal growth and new perspectives (Wielgus, 2015). Critical reflective differs from ordinary reflection skills in that it focuses on examining personal beliefs and assumptions and testing unfounded expectations. Critical reflective in reflective thinking can increase in problem-based learning environments (Taylor, 2017). The four essential elements in critical reflective are assumption analysis, contextual awareness, imaginative speculation, and reflective skepticism. Critical reflective aims to uncover the relationship between assumptions and facts, construct new ideas and has a positive correlation with critical thinking (Erdoğan, 2020; Sari & Nada, 2022; Tican & Taspinar, 2015; Waluya et al., 2024). Critical Reflective has a positive and significant influence on Reflective Thinking with a CR value (t statistic > t table (15.026> 1.653) and a path coefficient of 0.330, this coefficient indicates that the better critical reflective will increase reflective thinking.

Reflective plays a crucial role in developing expertise and improving professional practice in various fields, including education. Reflective enhances problem-solving, decision-making, and complex thinking skills and correlates with better test performance (Byrd, 2021; Rodgers, 2002). Reflective has a positive and significant effect on Reflective Thinking with a CR value (t statistic > t table (18.058 > 1.653) and a path coefficient of 0.381; this coefficient indicates that the better reflective will increase reflective thinking. reflection is a useful learning strategy, and reflective thinking is an essential characteristic of academic excellence (Kinghorn et al., 2021; Titus & Muttungal, 2024)

Based on the results of data analysis, habitual action has the least influence compared to the other three indicators on reflective thinking skills. Habitual action involves a form of embodied, embedded reasoning and knowing rather than just automatic responses. Conscious reflection and self-awareness are required to develop a reflexive habitus that allows skilled performers to refine and adapt their embodied actions (McGuirk, 2016; Toner, 2017). Habitual action has a positive and significant effect on Reflective Thinking with a CR value (t statistic> t table (3.818 > 1.653) and a path coefficient of 0.129; this coefficient indicates that the better the habitual action will increase Reflective Thinking. This finding highlights the importance of understanding the relationship between habitual action and reflective thinking in various contexts (Fynes-Clinton et al., 2024).

Reflective thinking is important for students, teachers, and prospective mathematics teachers to master. Several studies show that reflective thinking is effectively applied in learning mathematics materials. Reflective thinking is successful in algebraic problem solving using cognitive conflict in solving parabola problems and story problems on the material of the Three Variable Linear Equation System (Aprela et al., 2024; Kholid et al., 2024; Mawla & Nurcahyo, 2024). Students see a good teacher as someone who can make learning fun, show creativity in presenting learning materials, motivate, and make connections between science and everyday life. Students with a high interest in learning and higher levels of self-regulation support tend to be more active and have a high level of reflective thinking (Radović et al., 2024; Sarwi et al., 2024; Ulya & Utami, 2024).

Conclusion

Based on the data analysis results, it is known that understanding is the most influential indicator of reflective thinking, with a path coefficient value of 0.404 and a t-statistic value>ttable of 19.430 > 1.653. Meanwhile, habitual action is the indicator with the lowest influence with a path coefficient value of 0.129 and tstatistic >ttable of 3.818 > 1.653. In addition, critical reflection and reflection have a significant effect based on the path coefficient values of 0.330 and 0.381, respectively. This shows that the four indicators significantly influence the reflective thinking of mathematics teacher students based on outdoor play and game-based contextual learning activities.

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