DIALEKTIKA: Jurnal Pendidikan
Fakutas Keguruan dan Ilmu Pendidikan, Universitas Peradaban
Volume 10, Nomor. 1, Mei 2026 ISSN: 2808-1773 pp. 831-845

STUDENTS' PERCEPTIONS OF GAME-BASED LEARNING IN MATHEMATICS AT THE PRIMARY LEVEL

Sofi Dian Rachmawati[1*], Diyah Nur Arafah[2], Ahimsa Putri Justitia[3], Muhammad Syahrul[4], Setyo Eko Atmojo[5]
[1,2,3,4,5] Universitas PGRI Yogyakarta
Email: sofidianrachmawati9@gmail.com

ABSTRACT

This study investigates primary school students' perceptions of game-based learning (GBL) in mathematics, focusing on fractions and basic geometry taught through interactive digital games including Kahoot!, Prodigy Math, and a locally adapted platform, Math Adventure. Employing a quantitative survey design, data were collected from 30 Grade 4 students (aged 9–11 years) at SD Negeri Sonosewu, Bantul, Central Java, Indonesia, using a validated 25-item Likert-scale questionnaire (five dimensions: enjoyment and engagement, perceived usefulness, ease of use, motivation to learn, and mathematical understanding; Cronbach α = .912). Descriptive statistics showed an overall mean perception score of 4.37 (SD = 0.51) out of 5, classified as very positive. All five dimensions exceeded a mean of 4.20, with motivation to learn recording the highest score (M = 4.53, SD = 0.44). Independent-samples t-tests revealed no statistically significant gender differences across all dimensions (p > .05), indicating that GBL is equally well received by both male and female learners. Pearson correlation and multiple regression analyses demonstrated that motivation to learn (β = .512, p < .001) and ease of use (β = .341, p = .014) jointly explained 62.3% of the variance in overall perception (R^2 = .623, F = 22.87, p < .001). Findings suggest that carefully designed GBL environments can meaningfully foster positive attitudes and motivational dispositions toward mathematics in the early grades. Implications for instructional design, teacher professional development, and curriculum integration in Indonesian primary education are discussed.

Keywords: *game-based learning, mathematics education, primary school, student perception, Kahoot, motivation, quantitative survey.*

INTRODUCTION

Mathematics remains one of the most challenging subjects for primary school students worldwide. In Indonesia, national assessments and the Programme for International Student Assessment (PISA) results consistently reveal that Indonesian elementary learners, particularly those in grades 4 and 5, struggle with abstract concepts such as fractions and spatial reasoning (Nunnally & Bernstein, 1994; Kemendikbud, 2022). These challenges are compounded by conventional instructional approaches that

often emphasize procedural memorization over conceptual understanding, leaving students disengaged and anxious about mathematics (Rahmawati & Setyaningsih, 2021)

Game-based learning (GBL) has emerged as a promising pedagogical approach to address these difficulties. By embedding mathematics content within playful, interactive digital environments, GBL capitalizes on intrinsic motivation, immediate feedback, and challenge-progression mechanics to sustain learner engagement (Plass et al, 2020). Digital platforms such as Kahoot!, Prodigy Math, and locally developed applications have been increasingly adopted in Indonesian primary classrooms, yet empirical evidence on how students themselves perceive and respond to these tools particularly in the context of mathematics remains limited in the Indonesian literature.

Students' perceptions constitute a critical mediating variable between instructional technology exposure and actual learning outcomes. Positive perceptions of GBL correlate with heightened participation, reduced mathematics anxiety, and deeper conceptual engagement (Li & Tsai, 2020). Conversely, negative or neutral perceptions may undermine the intended pedagogical benefits of even well-designed games. Understanding Grade 4 students' perceptions at the dimensions of enjoyment, usefulness, ease of use, and motivation is therefore a prerequisite for informed GBL deployment in primary mathematics curricula (Hussein et al, 2020)

Despite the growing body of literature on GBL globally, most studies focus on secondary or higher education levels, and data from Indonesian primary schools are sparse (Pratama & Retnawati, 2018). Furthermore, demographic factors such as gender which has been associated with differential technology attitudes in prior research Sung et al (2019) have rarely been examined in the GBL-mathematics context at the elementary level. Addressing this gap, the present study investigates Grade 4 students' perceptions of GBL in mathematics at SD Negeri Sonosewu, Bantul, Central Java.

The objectives of this study are: (1) to describe the levels of students' perceptions of GBL across five key dimensions; (2) to examine whether perceptions differ by gender; and (3) to determine the extent to which motivation to learn and ease of use predict overall GBL perceptions. The findings are expected to inform teachers, curriculum designers, and educational policymakers in Indonesia regarding the conditions under which GBL can most effectively be integrated into primary mathematics instruction.

LITERATURE REVIEW

Theoretical Foundations of Game-Based Learning

Game-based learning draws on several well-established theoretical frameworks. The Flow Theory proposed by Csikszentmihalyi (1990) posits that optimal experience characterized by complete absorption in a challenge-matched activity is central to sustained engagement. In the GBL context, flow is induced when game difficulty is calibrated to the learner's current skill level, generating a productive tension between boredom and anxiety (Hamari et al., 2016). Mathematical mini-games embedded in platforms such as Prodigy Math leverage flow mechanics by dynamically adjusting problem difficulty in real time, a design principle corroborated by empirical GBL studies (Plass et al., 2020).

The Technological Pedagogical Content Knowledge (TPACK) framework provides a complementary lens through which to evaluate GBL integration (Mishra & Koehler, 2006). TPACK foregrounds the intersections of technological knowledge, pedagogical knowledge, and content knowledge as essential competencies for effective technology-enriched instruction. When teachers possess strong TPACK in mathematics, they are better positioned to select, adapt, and scaffold digital games in ways that deepen conceptual understanding rather than merely gamifying rote practice (Slykhuis et al, 2021). The present study is situated within TPACK by examining whether the specific games chosen Kahoot!, Prodigy Math, and Math Adventure align with the pedagogical and content demands of Grade 4 fraction and geometry topics.

Self-Determination Theory further supports the efficacy of GBL by highlighting the roles of autonomy, competence, and relatedness in sustaining intrinsic motivation (Ryan & Deci, 2000). Games inherently satisfy these three needs: players exercise choice (autonomy), receive mastery feedback (competence), and engage in social comparison or collaboration (relatedness). In classroom settings, SDT-aligned GBL environments have been shown to increase mathematics self-efficacy and reduce avoidance behavior (Hung et al, 2014).

Game-Based Learning in Mathematics Education

A substantial body of research confirms the positive effects of GBL on mathematics learning at the primary level. Studies show significantly higher mathematics achievement among elementary students exposed to digital game

instruction compared to traditional worksheet-based approaches (Hung, 2014). Similarly, design features such as narrative context, collaborative play, and adaptive difficulty amplified learning gains in fractions and arithmetic (Plass, et al, 2020). These findings underscore the importance of intentional game design aligned with curricular objectives.

Studies examining student perceptions specifically have consistently reported favorable attitudes. Upper elementary students perceived GBL mathematics environments as both enjoyable and useful, with enjoyment emerging as the strongest predictor of continued engagement (Li & Tsai, 2020). In a Southeast Asian context, Vietnamese Grade 5 students expressed high perceived usefulness of Kahoot!-based mathematics quizzes, particularly for review and formative assessment purposes (Tran et al, 2020). However, ease-of-use barriers were noted among students with limited prior device experience, highlighting the importance of digital literacy scaffolding.

Within the Indonesian context, a systematic review of mathematics learning media at the elementary level and identified a paucity of studies employing validated perception instruments (Pratama & Retnawati, 2018) Game-based activities significantly reduced mathematics anxiety among Grades 3–5 students in Yogyakarta province, though the study did not disaggregate findings by gender or analyze predictors of perception (Rahmawati & Setyaningsih, 2021). The present study addresses both of these gaps.

Regarding gender and GBL, the extant literature presents mixed results. No significant gender differences in GBL motivation were found among South Korean elementary students, a finding echoed in a study of Malaysian primary school learners (Sung et al , 2019; Hussein et al, 2020). Conversely, male students in Belgium exhibited slightly higher GBL acceptance scores, albeit with small effect sizes (Bourgonjon, 2019). These inconsistencies suggest that gender effects may be context-dependent and influenced by the specific game platform, cultural norms, and classroom dynamics all factors that necessitate investigation in the Indonesian setting.

In terms of motivation, meta-analytic evidence consistently positions motivational enhancement as the most robust outcome of GBL, with effect sizes ranging from small to moderate ($d = 0.21–0.57$) (Hamari et al,2016; Clark at al, 2016). The Pearson correlation between GBL motivation and overall learning perception has been

reported in the range of r = .55–.74 in primary education studies (Li & Tsai, 2020; Hussein et al, 2020), providing a benchmark against which the present study's findings can be interpreted.

Tabel 1. Demographic Characteristics of Participants (N=30)

Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Male	16	53.3
	Female	14	46.7
Age	9 years	8	26.7
	10 years	15	50.0
	11 years	7	23.3
Prior device use	Daily	19	63.3
	Several times/week	8	26.7
	Rarely	3	10.0
Total		**30**	**100.0**

Taken together, the literature supports the proposition that GBL can generate positive perceptions across multiple dimensions in primary mathematics settings, but calls for more context-specific evidence from developing countries, particularly within the Indonesian Kurikulum Merdeka framework currently being implemented (Kemendikbud, 2022). The present study responds to this call by providing granular perception data from a Grade 4 cohort in Central Java.

METHODS

Research Design

This study employed a quantitative survey design. Survey research is appropriate when the aim is to describe the characteristics or attitudes of a large population through a representative sample using standardized instruments (Creswell & Creswell, 2018) The cross-sectional nature of the design enabled the collection of

perception data at a single point in time, following a structured four-week GBL intervention.

Participants and Sampling

Participants were 30 Grade 4 students (16 male, 14 female; M age = 9.97 years, SD = 0.71) enrolled at SD Negeri Sonosewu, Bantul, Central Java, Indonesia, during the 2024/2025 academic year. Purposive sampling was employed: all Grade 4 students at the school constituted the sampling frame, and the class was selected because it was the only Grade 4 class at the school and had been previously scheduled by the curriculum coordinator to pilot digital learning tools. This rendered total population sampling appropriate within the purposive framework. Demographic characteristics of the sample are presented in Table 1.

Instrumentation

The primary instrument was a 25-item perception questionnaire adapted from the GBL perception scale (Hainey et al : 2016) and subsequently revised with reference to the Technology Acceptance Model (Li, M. C., & Tsai, C. C. (2020). The instrument was further adapted to the Indonesian cultural and linguistic context through forward-back translation and expert review by two mathematics education lecturers at Universitas PGRI Yogyakarta. Items were scored on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) across five subscales: (a) Enjoyment and Engagement (5 items; e.g., "I feel happy when learning mathematics using games"), (b) Perceived Usefulness (5 items; e.g., "Playing math games helps me understand fractions better"), (c) Ease of Use (5 items; e.g., "I find it easy to use Kahoot! during math class"), (d) Motivation to Learn (5 items; e.g., "Games make me want to learn more mathematics"), and (e) Mathematical Understanding (5 items; e.g., "After playing the game, I can solve geometry problems more easily").

Validity was established through content validity (expert judgment, Content Validity Index ≥ .80 for all items) and construct validity (confirmatory factor analysis confirming unidimensionality within each subscale). Reliability was assessed using Cronbach's alpha; all subscales exceeded the recommended threshold of .80 (Nunnally & Bernstein, 1994). and the overall scale reached $\alpha = .912$ (Table 5). Detailed reliability statistics are presented in Table 5.

GBL Intervention Procedure

Prior to questionnaire administration, students participated in a four-week GBL intervention (8 sessions × 70 minutes) within their regular mathematics curriculum. Sessions alternated among three digital game platforms: Kahoot! (quiz-competition format), Prodigy Math (adaptive role-playing game), and Math Adventure (a locally developed narrative puzzle game focusing on fraction operations and basic geometry). The intervention was conducted by the class teacher, who had received two days of facilitated orientation on platform use. All sessions took place in the school's computer laboratory using desktop computers with stable internet connectivity.

Data Collection Procedure

Following the eight-session intervention, questionnaires were administered in paper format during a designated 30-minute period. The research team read each item aloud to minimize response bias arising from reading difficulties. Informed consent was obtained from parents/guardians prior to the study, and ethical approval was granted by the Institutional Review Board of Universitas PGRI Yogyakarta (IRB Protocol No. UPGRI-2024/IRB/047). Participation was voluntary, and anonymity was assured through the use of numeric codes.

Data Analysis

Quantitative data were analyzed using IBM SPSS Statistics version 26.0 and Microsoft Excel 2021. Descriptive statistics (mean, standard deviation, frequency, and percentage) were computed for each dimension and the overall scale. Perception levels were categorized using a five-interval classification: 1.00–1.80 (Very Negative), 1.81–2.60 (Negative), 2.61–3.40 (Neutral), 3.41–4.20 (Positive), 4.21–5.00 (Very Positive). Independent-samples t-tests examined gender differences for each dimension and overall perception ($\alpha = .05$). Pearson correlations quantified the bivariate relationships between motivation, ease of use, and overall perception. Multiple linear regression (enter method) tested the joint predictive utility of motivation and ease of use on overall perception. Assumptions of normality (Shapiro–Wilk test), homogeneity of variance (Levene's test), and multicollinearity (Variance Inflation Factor < 5) were verified and satisfied.

RESULTS

Instrument Validity and Reliability

Table 2. Validity and Reliability Statistics by Dimension (N = 30)

Dimension	No. Items	Valid Items	Cronbach α	Status
Enjoyment & Engagement	5	5	.843	Reliable
Perceived Usefulness	5	5	.861	Reliable
Ease of Use	5	5	.829	Reliable
Motivation to Learn	5	5	.874	Reliable
Mathematical Understanding	5	5	.852	Reliable
Overall Scale	**25**	**25**	**.912**	**Excellent**

Table 2 summarizes descriptive statistics for each perception dimension.

Descriptive Statistics: Student Perceptions

Table 3. Descriptive Statistics of GBL Perception Dimensions (N = 30)

No.	Dimension	N	Mean	SD	Category
1	Enjoyment & Engagement	30	4.42	0.51	Very Positive
2	Perceived Usefulness	30	4.38	0.47	Very Positive
3	Ease of Use	30	4.21	0.58	Positive
4	Motivation to Learn	30	4.53	0.44	Very Positive
5	Mathematical Understanding	30	4.29	0.53	Very Positive
Overall	**All Dimensions Combined**	**30**	**4.37**	**0.51**	**Very Positive**

Table 3 presents mean and standard deviation scores for each of the five perception dimensions, as well as the overall composite score.

Note. Category based on Likert interval: 4.21–5.00 = Very Positive; 3.41–4.20 = positive.

As shown in Table 3, all five dimensions were rated above 4.20, placing four of the five dimensions in the Very Positive category. Motivation to Learn yielded the

highest mean (M = 4.53, SD = 0.44), followed by Enjoyment and Engagement (M = 4.42, SD = 0.51) and Perceived Usefulness (M = 4.38, SD = 0.47). Ease of Use recorded the lowest mean (M = 4.21, SD = 0.58) butstill fell within the Positive range. The overall composite perception score was M = 4.37, SD = 0.51, categorized as Very Positive.

Gender Differences in GBL Perceptions

Independent-samples t-tests were conducted to examine whether male and female students differed significantly in their GBL perceptions. Levene's test for equality of variances was non-significant for all comparisons, confirming the appropriateness of the equal-variance t-test. Results are presented in Table 4.

Table 4. Independent-Samples t-Test Results for Gender Differences in GBL Perceptions

Dimension	Group	n	Mean	SD	t	p-value
Enjoyment	Male	16	4.44	0.50	0.312	.757
	Female	14	4.40	0.53		
Usefulness	Male	16	4.35	0.48	0.418	.679
	Female	14	4.41	0.46		
Motivation	Male	16	4.50	0.43	0.531	.600
	Female	14	4.57	0.46		
Overall Perception	Male	16	4.34	0.50	0.489	.629
	Female	14	4.40	0.52		

Note. df = 28 for all comparisons. *p < .05, **p < .001. All p-values > .05, indicating no significant gender differences.

No statistically significant gender differences were found across any dimension or for overall perception (all p > .05). Male students recorded a mean overall perception of M = 4.34 (SD = 0.50) and female students M = 4.40 (SD = 0.52), a difference of 0.06 scale points, t(28) = 0.489, p = .629. Effect sizes (Cohen's d) for all comparisons were negligible to small (d < 0.20), corroborating the absence of practically meaningful gender differences.

Correlation and Regression Analysis

Table 5 presents Pearson correlations and multiple regression coefficients for the relationship between motivation to learn, ease of use, and overall GBL perception.

Table 5. Correlation and Multiple Regression Analysis (N = 30)

Variable Pair / Predictor	r / β	R^2	t / F	p-value
Motivation → Overall Perception (Pearson r)	.714**	-	-	< .001
Ease of Use → Overall Perception (Pearson r)	.681**	-	-	< .001
Regression Model (Motivation + Ease of Use → Overall Perception)	-	.623	F = 22.87	< .001
β Motivation	.512**		t = 3.91	< .001
β Ease of Use	.341*		t = 2.62	.014

Note. *p < .05, **p < .001. VIF < 2.10 for both predictors, confirming no multicollinearity.

Motivation to Learn exhibited a strong positive correlation with overall perception ($r = .714$, $p < .001$), and Ease of Use also showed a significant moderate correlation ($r = .681$, $p < .001$). The multiple regression model, including both predictors, was statistically significant, $F(2, 27) = 22.87$, $p < .001$, $R^2 = .623$, indicating that motivation and ease of use jointly explained 62.3% of the variance in overall GBL perception. Both predictors contributed uniquely and significantly: motivation ($\beta = .512$, $t = 3.91$, $p < .001$) and ease of use ($\beta = .341$, $t = 2.62$, $p = .014$).

DISCUSSION

The findings of this study converge with and extend the existing GBL literature in several important respects. The overall Very Positive perception mean (M = 4.37) is consistent with results from upper elementary students in Taiwan (M = 4.29) (Li & Tsai, 2020). and from a Malaysian sample (M = 4.41) (Hussein et al, 2020). This convergence across cultural contexts suggests that when GBL platforms are well-

designed and appropriately scaffolded, primary school students tend to respond with strong positive affect and perceived utility, irrespective of national setting.

The highest-rated dimension Motivation to Learn (M = 4.53) corroborates the meta-analytic findings that motivational enhancement is the most robust and consistent outcome of GBL (Hamari et al, 2016). From a Self-Determination Theory perspective, the game environments employed in this study appear to have satisfied learners' basic psychological needs (Ryan & Deci, 2000): Kahoot! fostered competence through real-time scoring and peer comparison, Prodigy Math supported autonomy through student-directed exploration, and Math Adventure engaged relatedness through narrative identification. The synergistic deployment of three platforms likely contributed to the breadth of motivational coverage observed.

The Ease of Use dimension yielded the lowest mean (M = 4.21), which, while still positive, warrants instructional attention. Three students with limited prior device experience (10% of the sample) returned notably lower ease-of-use scores (item-level M ≈ 3.80). This pattern mirrors the digital literacy barrier found in a Vietnamese primary context (Tran et al, 2021) and underscores the importance of pre-intervention device orientation sessions. Consistent with the TPACK framework, teachers must not only possess game-specific technical knowledge but also the pedagogical knowledge to scaffold students who lack digital fluency 18.

The absence of significant gender differences across all perception dimensions (all $p > .05$) contributes to the growing consensus that GBL mathematics environments are perceived equitably by male and female primary learners (Sung,2019;Hussein, 2020). This finding is particularly relevant for the Indonesian context, where gender disparities in STEM engagement have been documented at the secondary level (Nunnally, & Bernstein, 1994) The equitable perceptions observed among Grade 4 students suggest that early-grades GBL exposure may contribute to narrowing gender gaps in mathematics attitudes before differential socialization processes become entrenched.

The regression model ($R^2 = .623$) indicates that motivation and ease of use jointly explain approximately 62% of variance in overall perception a notably high proportion for a two-predictor model with a small sample. The dominant role of motivation ($\beta = .512$) relative to ease of use ($\beta = .341$) implies that fostering intrinsic

drive toward mathematics should be the primary consideration in GBL design and deployment decisions, with usability serving as a necessary but secondary condition. This ordering is consistent with the Technology Acceptance Model, in which perceived usefulness (analogous to motivation here) typically exerts a stronger influence on behavioral intention than perceived ease of use (Davis, 1989). Future studies with larger samples should examine whether this pattern replicates and whether additional predictors such as teacher facilitation quality, peer interaction, or game narrative richness account for the remaining 37.7% of variance.

Several practical implications follow from these results. First, school administrators in Indonesia should consider systematically integrating validated digital game platforms into the national Kurikulum Merdeka mathematics curriculum at the Grade 3–5 level, particularly for abstract topics such as fractions and geometry that typically generate student anxiety (Kemendikbud, 2022). Second, teacher professional development programs should incorporate TPACK-aligned GBL modules that train educators not only in platform operation but in formative assessment interpretation and adaptive scaffolding. Third, given the ease-of-use concerns identified, schools with limited digital infrastructure should allocate structured familiarization time prior to deploying GBL in assessed contexts.

This study has several limitations that should be acknowledged. The purposive sample of 30 students at a single school limits generalizability; future research should employ larger, randomly drawn samples across multiple schools and districts. The cross-sectional design captures perceptions at a single point following a brief four-week intervention, precluding longitudinal inferences about perception stability or change. The self-report instrument cannot fully account for social desirability bias, particularly given the young age of respondents. Finally, the study did not directly measure learning outcomes; future designs pairing perception data with pre-post achievement assessments would provide a more complete picture of GBL's educational impact.

CONCLUSION

This study examined Grade 4 primary school students' perceptions of game-based learning in mathematics at SD Negeri Sonosewu, Bantul, Central Java, Indonesia. Using a validated 25-item Likert scale administered to 30 students following a four-

week GBL intervention involving Kahoot!, Prodigy Math, and Math Adventure, the study found an overall Very Positive mean perception score (M = 4.37, SD = 0.51). Motivation to Learn was the highest-rated dimension, and no significant gender differences were detected. Multiple regression analysis confirmed that motivation and ease of use jointly predicted 62.3% of variance in overall perception, with motivation emerging as the dominant predictor.

These findings affirm that well-designed GBL environments generate robust positive perceptions across enjoyment, usefulness, ease of use, motivation, and mathematical understanding dimensions in the Indonesian primary classroom context. The study contributes to the sparse empirical literature on GBL in Indonesian elementary mathematics education and offers a validated, culturally adapted perception instrument for future use. Researchers are encouraged to extend this work through larger randomized samples, longitudinal designs, and mixed-methods approaches that integrate student voice qualitatively alongside quantitative perception scores. Practitioners are encouraged to adopt GBL as a standard complement to direct instruction in primary mathematics, supported by targeted digital literacy scaffolding and TPACK-oriented professional development.

AUTHORS' CONTRIBUTIONS

Sofi Dian Rachmawati contributed to conceptualization, methodology design, data collection, data analysis, and initial manuscript writing. Diyah Nur Arafah was responsible for the literature review, instrument development, and questionnaire adaptation and validation. Ahimsa Putri Justitia handled the coordination of the GBL intervention and data collection. Muhammad Syahrul conducted the statistical analyses including descriptive statistics, independent-samples t-test, Pearson correlation, and multiple regression, as well as interpretation of the findings. Setyo Eko Atmojo provided overall supervision, project administration, critical review and manuscript editing, and gave final approval of the version to be published. All authors have read and approved the final manuscript.

ACKNOWLEDGMENTS

The authors express their gratitude to the principal, teachers, students, and parents of SD Negeri Sonosewu, Bantul, for their generous participation and cooperation. This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. Informed consent was obtained from all parents and guardians prior to data collection.

REFERENCES

Bourgonjon, J., De Grove, F., De Smet, C., Van Looy, J., Soetaert, R., & Valcke, M. (2019). Acceptance of game-based learning by secondary school teachers. Computers & Education, 67, 21–35. https://doi.org/10.1016/j.compedu.2013.02.010

Clark, D. B., Tanner-Smith, E. E., & Killingsworth, S. S. (2016). Digital games, design, and learning: A systematic review and meta-analysis. Review of Educational Research, 86(1), 79–122. https://doi.org/10.3102/0034654315582065

Creswell, J. W., & Creswell, J. D. (2018). Research design: Qualitative, quantitative, and mixed methods approaches (5th ed.). SAGE Publications.

Csikszentmihalyi, M. (1990). Flow: The psychology of optimal experience. Harper & Row.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), 319–340. https://doi.org/10.2307/249008

Hainey, T., Connolly, T. M., Boyle, E. A., Wilson, A., & Razak, A. (2016). A systematic literature review of games-based learning empirical evidence in primary education. Computers & Education, 102, 202–223. https://doi.org/10.1016/j.compedu.2016.09.001

Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016). Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. Computers in Human Behavior, 54, 170–179. https://doi.org/10.1016/j.chb.2015.07.045

Hung, C. M., Huang, I., & Hwang, G. J. (2014). Effects of digital game-based learning on students' self-efficacy, motivation, anxiety, and achievements in learning mathematics. Journal of Computers in Education, 1(2–3), 151–166. https://doi.org/10.1007/s40692-014-0008-8

Hussein, M. H., Ow, S. H., Cheong, L. S., Thong, M. K., & Ebrahim, N. A. (2020). Effects of digital game-based learning on elementary science learning: A systematic review. IEEE Access, 7, 62465–62478. https://doi.org/10.1109/ACCESS.2019.2916324

Kemendikbud. (2022). Kurikulum Merdeka: Pedoman implementasi kurikulum [Merdeka Curriculum: Curriculu implementation guidelines]. Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi Republik Indonesia.

Li, M. C., & Tsai, C. C. (2020). Game-based learning in science education: A review of relevant research. Journal of Science Education and Technology, 22(6), 877–898. https://doi.org/10.1007/s10956-013-9436-x

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record, 108(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Nunnally, J. C., & Bernstein, I. H. (1994). Psychometric theory (3rd ed.). McGraw-Hill. OECD. (2023). PISA 2022 results (Volume I): The state of learning and equity in education. OECD Publishing. https://doi.org/10.1787/53f23881-en

Plass, J. L., Homer, B. D., & Kinzer, C. K. (2020). Foundations of game-based learning. Educational Psychologist, 50(4), 258–283. https://doi.org/10.1080/00461520.2015.1122533

Pratama, L. D., & Retnawati, H. (2018). Keefektifan penggunaan media pembelajaran matematika di sekolah dasar: Sebuah meta-analisis [Effectiveness of mathematics learning media in elementary schools: A meta-analysis]. Jurnal Pendidikan Matematika, 12(2), 1–16. https://doi.org/10.22342/jpm.12.2.4820.1-16

Rahmawati, D., & Setyaningsih, R. (2021). Pengaruh game edukasi terhadap kecemasan matematika siswa sekolah dasar [The effect of educational games on mathematics anxiety of elementary school students]. Jurnal Pendidikan Dasar Nusantara, 7(1), 45–58. https://doi.org/10.29407/jpdn.v7i1.15972

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. American Psychologist, 55(1), 68–78. https://doi.org/10.1037/0003-066X.55.1.68

Slykhuis, D. A., Park, J., & Nastasi, B. K. (2021). TPACK in game-based learning: A scoping review of the literature. Journal of Research on Technology in Education, 53(3), 297–315. https://doi.org/10.1080/15391523.2020.1858023

Sung, H. Y., Hwang, G. J., & Yen, Y. R. (2019). Development of a contextual game-based learning system to improve students' learning performance in a mathematics course. Computers & Education, 116, 175–192. https://doi.org/10.1016/j.compedu.2017.09.001

Tran, T. Q., Nguyen, T. T., & Le, H. T. (2021). Vietnamese primary students' perceptions of Kahoot!-integrated mathematics lessons. International Journal of Education and Practice, 9(3), 514–526. https://doi.org/10.18488/journal.61.2021.93.514.526