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The Impact of Game-Based Learning Using Minecraft on Science Teaching Performance: A Qualitative Study

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Abstract
This study explores the impact of game-based learning (GBL) using Minecraft on the teaching performance of novice science teachers during their practicum sessions. While game-based learning has been widely acknowledged for enhancing student engagement, its influence on teacher development, particularly among novice educators, remains under-researched. This study specifically investigates how Minecraft, as an immersive and interactive educational tool, influences teaching preparation, classroom performance, and teacher motivation during practicum. Employing a qualitative research design, data were collected from a cohort of mathematics teachers integrating Minecraft into their science lessons through reflective student diaries, semi-structured interviews, and classroom observations. Thematic analysis of the data revealed that the integration of Minecraft encouraged teachers to adopt innovative lesson planning strategies, fostered active and student-centered teaching practices, and significantly boosted their motivation to embrace technology-enhanced learning. Additionally, teachers reported improved confidence in utilizing digital tools and greater satisfaction with their teaching experiences. These findings highlight the transformative potential of game-based learning in teacher education programs, offering practical insights for enhancing practicum experiences and preparing teachers to meet the demands of 21st-century classrooms. The study concludes with recommendations for incorporating GBL frameworks into teacher training curricula to promote pedagogical innovation and sustained motivation among novice teachers.
Keywords: Game-Based Learning, Minecraft, Science Teaching, Teacher Practicum, Motivation, Performance

Introduction

Game-based learning (GBL) has rapidly evolved into a compelling pedagogical strategy that blends educational content with engaging game mechanics, enhancing both student engagement and teaching efficacy. Among GBL platforms, Minecraft has emerged as a versatile sandbox environment enabling immersive, interactive, and collaborative learning experiences. Although substantial literature focuses on GBL's benefits for student outcomes, there is limited understanding of how GBL influences novice teachers, particularly during practicum, in the Malaysian context.

Under the Malaysia Education Blueprint (MEB) 2013–2025, the Ministry of Education aims to transform the national education system into one that fosters critical thinking, creativity, and digital fluency, as outlined in revised KSSR/KSSM curricula frameworks (Education in Malaysia, n.d.; MEB, 2013). The policy further emphasizes school-based professional development and access to ICT tools to empower teachers as instructional leaders. Wave 3 (2021–2025) underscores deploying ICT for teaching and learning, particularly in STEM subjects, to support nationally-declared shifts toward Inquiry-Based Learning and Higher Order Thinking Skills (HOTS) (Education in Malaysia, n.d.).Despite policy momentum, implementation of game-based STEM modules, especially in science classrooms, faces significant barriers. A needs-analysis study involving secondary science teachers in Kedah revealed that most lacked training, resources, and confidence to adopt game-based modules aligned to KSSM science outcomes (Tangkui & Keong, 2023). A broader survey of Malaysian physics teachers found that nearly 70% had never incorporated any game-based learning approaches, citing infrastructure constraints, curricular misalignment, and inadequate support as key challenges Another study on STEM integration challenges echoed similar infrastructure and teacher competency issues, reinforcing the gap between the ambitious MEB vision and actual classroom practices.

The Blueprint also promotes strengthening teacher professional development through school-based training, peer collaboration, and career progression pathways tied to pedagogical and technological competence (MEB, 2013–2025) Globally, educational theorists advocate frameworks like TPACK-G (Technological Pedagogical and Content Knowledge for Games) to prepare educators to design, adapt, and facilitate game-based learning experiences effectively in STEM disciplines. Teachers' adoption of GBL requires not only technological literacy but also alignment with content and pedagogical strategies. However, Malaysian preservice programmes rarely incorporate frameworks such as TPACK-G systematically during placement or internship experiences (De Smet, 2024) Although Malaysia's policy discourse emphasizes GBL and STEM pedagogy, novice teachers frequently lack opportunities to experiment with game-based tools during their practicum, limiting their ability to integrate technology into lesson planning and delivery. Empirical studies in Malaysia have largely focused on student outcomes or secondary-level physics, leaving novice teacher experiences during practicum underexplored. There is scarce qualitative research capturing how GBL tools like Minecraft affect teacher planning practices, classroom performance, and intrinsic motivation.

This study addresses this gap by exploring how integrating Minecraft-based GBL during practicum enriches novice science teachers' lesson preparation, classroom performance, and motivation. Using reflective diaries, interviews, and observations, the research examines how these experiences align with policy goals such as those in the MEB, and how they might inform teacher training curricula, professional development strategies, and STEM integration frameworks in Malaysian teacher education.

The integration of technology-enhanced learning, particularly game-based learning (GBL), has been identified as a strategic priority under Malaysia's Education Blueprint 2013–2025, which emphasizes the development of 21st-century teaching competencies, STEM integration, and the adoption of innovative pedagogies. Despite these policy aspirations, many novice teachers entering the profession continue to face challenges in adopting technology-driven instructional strategies during their practicum. Current teacher training programs often provide limited exposure to game-based tools, resulting in low confidence and underutilization of such methods in classroom settings. While research on GBL has predominantly focused on student engagement and learning outcomes, there is a lack of empirical studies examining its influence on teachers themselves—especially novice science teachers during practicum. This gap in the literature is critical, as practicum experiences shape early professional identities and long-term teaching practices. Furthermore, there is insufficient understanding of how tools like Minecraft, which allows immersive and interactive lesson design, impact teachers' preparation, classroom performance, and motivation to innovate in science teaching. Addressing this gap is essential to inform teacher education programs and to support the alignment of national policies with classroom realities.

To address this problem, the study sets out to examine the impact of game-based learning using Minecraft on novice science teachers' practicum experiences. Specifically, it seeks to understand how Minecraft influences various aspects of teaching practice, from lesson planning to classroom delivery and professional motivation. This investigation is guided by three research questions:
1. How does Minecraft impact the teaching preparation of novice science teachers?
2. How does Minecraft influence their teaching performance during practicum?
3. How does Minecraft affect their motivation towards teaching science?

Literature Review

Game-Based Learning in Science Education

Game-based learning (GBL) has gained significant traction as an innovative instructional approach that merges educational content with interactive, game-like experiences, leading to improved teaching and learning outcomes in STEM education. Extensive research has demonstrated that GBL can significantly enhance student engagement, motivation, and conceptual understanding across science and mathematics disciplines (Lin & Aloe, 2021). Through immersive environments, students actively participate in problem-solving activities, which promote deeper understanding of abstract scientific concepts and foster intrinsic motivation to learn (Kim & Castelli, 2021; Wu et al., 2020). Meta-analyses indicate that GBL exerts moderate to large effects on a variety of learning domains—including cognitive gains, social interactions, emotional engagement, and sustained motivation (Lin & Aloe, 2021). These findings suggest that game mechanics—such as challenges, rewards, feedback, and narrative contexts—play a crucial role in shaping learning behaviors and outcomes.

GBL environments also support the development of higher-order thinking skills by encouraging learners to experiment, hypothesize, and reflect during gameplay. For example, Lameras et al. (2017) and Tawafak et al. (2020) highlighted that games promote critical thinking, collaboration, and problem-solving when embedded in well-structured pedagogical frameworks. Within science education, GBL has been found to effectively facilitate inquiry-based and active learning, where students engage in exploration and investigation rather than passive knowledge acquisition. This approach aligns with constructivist learning theories, which emphasize that knowledge is actively constructed by learners through interaction with their environment (Vygotsky, 1978; Piaget, 1970).

Studies in science classrooms have shown that GBL tools, including virtual simulations and sandbox environments, can stimulate conceptual change by enabling students to visualize and manipulate scientific phenomena that are otherwise difficult to observe in traditional classroom settings (Novak & Krajcik, 2016; Smith et al., 2018). For instance, simulations embedded in games allow students to model chemical reactions, test physical laws, and explore biological systems in safe, controlled virtual environments. Furthermore, GBL aligns with 21st-century skills frameworks, promoting competencies such as creativity, digital literacy, communication, and teamwork (Partnership for 21st Century Skills, 2019). These skills are critical not only for students but also for teachers who are tasked with fostering them.Despite the growing evidence of GBL's benefits for students, the implications for teachers—particularly novice educators—remain underexplored. Most studies have prioritized measuring student learning gains, overlooking how teachers' pedagogical beliefs, lesson preparation strategies, and classroom practices are shaped when they engage with GBL environments. There is a paucity of research investigating how GBL influences teacher confidence, instructional design skills, and willingness to innovate in science teaching. This gap is particularly significant in the context of teacher education programs, where practicum experiences play a pivotal role in shaping teaching identities and professional growth.

Additionally, while GBL theoretically aligns with frameworks such as Technological Pedagogical Content Knowledge (TPACK) and self-determination theory (SDT), empirical studies seldom examine how these theoretical perspectives manifest in teachers' adoption of GBL practices. Teachers need to develop an integrated understanding of how to use technology to support pedagogy and content delivery—a process that is often challenging without guided training or exposure to real-world game-based teaching experiences (Mishra & Koehler, 2006; Deci & Ryan, 2000). This underlines the urgency for studies focusing on how GBL tools, like Minecraft, can support novice teachers during their practicum by enhancing their pedagogical innovation, self-efficacy, and motivation to engage with emerging technologies.In conclusion, while GBL has been well-established as a catalyst for improving student learning, its potential to transform teachers' professional practices, particularly during the formative practicum stage, remains an understudied area. Investigating this dimension is crucial to understanding how game-based pedagogies can be effectively integrated into teacher education programs and how they can contribute to the broader goals of educational reform in the 21st century.

Research Design

This study employed a qualitative research design to obtain an in-depth understanding of novice teachers' lived experiences integrating Minecraft into their science lessons during practicum. Qualitative approaches are particularly suited to exploring complex phenomena where participant perspectives, context, and meaning construction are central to the research (Creswell & Poth, 2018). Through qualitative inquiry, this study was able to capture not only observable changes in teaching practices but also teachers' reflective thought processes and motivational shifts when engaging with game-based learning (Merriam &

Tisdell, 2016). The design adopted a case study approach, allowing for an in-depth examination of how Minecraft, as a game-based learning tool, impacted teaching preparation, performance, and motivation within authentic classroom environments.

Participants

The participants were 10 novice mathematics teachers in their final year of a Bachelor of Education program at a Malaysian public university. These teachers were undertaking their teaching practicum at various secondary schools and were instructed to integrate Minecraft Education Edition into their science lessons during the practicum period. Participants were purposefully selected based on their willingness to use Minecraft in lesson delivery and their basic digital literacy skills. Purposeful sampling is commonly used in qualitative research to select participants who can provide rich, relevant data (Palinkas et al., 2015). Prior to the study, participants received a brief training workshop on using Minecraft for science teaching to ensure baseline familiarity with the tool. Ethical approval was obtained, and informed consent was secured from all

Research Instruments

To capture comprehensive data aligned with the research questions, three instruments were developed and adapted from existing validated tools:

1. **Reflective Diary Template** – Adapted from Wallin et al. (2023), the diary included open-ended prompts guiding teachers to reflect on their **lesson preparation**, experiences with Minecraft-based teaching, challenges, and their own motivation. This instrument allowed collection of longitudinal reflections, providing rich qualitative insights.
2. **Semi-Structured Interview Protocol** – An interview guide was developed based on prior studies on teacher technology integration and GBL adoption (Kallio et al., 2016; Patton, 2015). The protocol consisted of **10 guiding questions** grouped into three domains: (a) preparation for teaching using Minecraft, (b) classroom performance during GBL lessons, and (c) motivation and perceptions about integrating game-based tools. Probing questions were included to allow deeper exploration of emergent themes.
3. **Classroom Observation Checklist** – The observation tool was adapted from Danielson's (2013) Framework for Teaching and Chang et al. (2022) GBL Observation Framework. It assessed teacher actions, instructional strategies, student engagement, and evidence of game-based learning integration. Observers also recorded descriptive field notes to capture contextual details beyond the checklist indicators.

Pilot Study

A pilot study was conducted with two novice teachers (not part of the main study sample) who were similarly undergoing practicum and integrating Minecraft into their science lessons. The objectives of the pilot were to; Test the clarity and relevance of diary prompts, interview questions, and observation indicators, ensure the feasibility of the data collection schedule during practicum and refine coding categories for anticipated thematic analysis.Feedback from the pilot participants resulted in minor modifications to the diary template (adding prompts on student reactions), rewording some interview questions for clarity, and simplifying observation indicators to make them more specific to Minecraft-based lesson contexts. Conducting a pilot enhanced the content validity of the instruments (Creswell & Poth, 2018).

Validity, Reliability, and Trustworthiness

In qualitative research, ensuring trustworthiness is critical to guarantee the credibility and rigor of findings (Lincoln & Guba, 1985). This study employed several strategies to establish credibility, dependability, confirmability, and transferability:Credibility: Triangulation was achieved by collecting data from multiple sources (diaries, interviews, and observations), allowing cross-verification of findings (Patton, 2015). Member checking was also implemented, where participants reviewed interview transcripts and preliminary findings to confirm accuracy.Dependability: An audit trail was maintained, documenting all research processes, coding decisions, and methodological choices. Peer debriefing sessions with two qualitative research experts were conducted to review coding frameworks and emerging themes, ensuring consistency in data interpretation.Confirmability: Researcher reflexivity was practiced throughout the study by maintaining reflective memos that documented potential biases and decisions during data analysis. This helped ensure that findings were grounded in participants' data rather than researcher assumptions.Transferability: Thick descriptions of the research context, participant profiles, and practicum settings were provided to allow readers to determine the applicability of findings to other contexts.

To strengthen instrument validity, the diary prompts, interview guide, and observation checklist were reviewed by three experts in STEM education and educational technology. Their feedback ensured alignment with the study's objectives and research questions. Reliability was enhanced through inter-rater agreement: two independent coders analyzed a subset of the data and achieved an agreement rate of over 85%, confirming consistency in coding themes (Miles, Huberman, & Saldaña, 2014).These measures collectively enhanced the study's rigor, ensuring that the results accurately reflect novice teachers' experiences with game-based learning using Minecraft during practicum.

Data Analysis

All qualitative data (diaries, interview transcripts, and observation notes) were subjected to thematic analysis, following Braun and Clarke's (2006) six-phase approach. Thematic analysis was chosen because of its flexibility and suitability for identifying patterns across diverse qualitative data sources. Data were first transcribed, coded, and organized into initial categories. Codes were then clustered into broader themes reflecting the research questions: teaching preparation, teaching performance, and motivation. NVivo software was used to manage and analyze data systematically. To ensure trustworthiness, techniques such as member checking, peer debriefing, and maintaining an audit trail were applied (Lincoln & Guba, 1985).

Findings

Impact on Teaching Preparation

The analysis of reflective diaries revealed that the integration of Minecraft encouraged participants to engage in more comprehensive and creative lesson planning. Teachers described how the use of Minecraft required them to think beyond traditional teaching strategies and align game-based tasks with science learning objectives. They incorporated problem-solving scenarios, virtual experiments, and collaborative projects within the game environment, which demanded deeper curriculum mapping and anticipatory thinking in planning lessons. This aligns with earlier findings that GBL requires teachers to design learner-centered lessons where gameplay mechanics are integrated into instructional goals (Lameras et al., 2017; Tawafak et al., 2020). The constructivist nature of Minecraft prompted teachers to plan learning activities that actively engaged students in exploration and knowledge construction, supporting studies by Vygotsky (1978) and Piaget (1970) which emphasize active participation as a core component of learning.

Impact on Teaching Performance

Observational data highlighted significant improvements in teaching performance. Teachers were seen using interactive strategies such as guided discovery, collaborative problem-solving, and in-game scaffolding techniques to support student learning. Classroom observations demonstrated that novice teachers managed classroom interactions more effectively during Minecraft-based lessons compared to traditional sessions, largely because students were actively engaged in tasks, reducing disruptive behavior. The findings mirror those of Holmberg et al. (2019) and Smith et al. (2018), who observed that the use of Minecraft in classrooms enhances teacher facilitation and student engagement. Moreover, the integration of game-based tasks allowed teachers to assume the role of facilitators rather than lecturers, a shift consistent with 21st-century pedagogical practices promoted in the Malaysia Education Blueprint (2013–2025).

Impact on Teaching Motivation

Interview data revealed that the use of Minecraft significantly boosted teachers' intrinsic motivation to teach science innovatively. Participants expressed excitement and satisfaction when witnessing students' enthusiasm and active involvement during lessons. Several teachers noted that the positive student responses motivated them to further experiment with technology-based strategies in future teaching. This resonates with self-determination theory (SDT), which posits that autonomy, competence, and relatedness enhance motivation (Deci & Ryan, 2000). Teachers reported that using Minecraft improved their confidence in integrating technology, aligning with studies by Ellison and Evans (2016) and De Smet (2024), which highlight how exposure to game-based environments can strengthen teachers' digital literacy and willingness to innovate.

Discussion

The findings of this study contribute to the growing body of evidence that game-based learning (GBL) positively influences both teaching and learning outcomes, extending the focus beyond students to include novice teachers. Similar to prior research, this study demonstrates that GBL enhances lesson planning, classroom delivery, and teacher motivation (Lin & Aloe, 2021; Novak & Krajcik, 2016).

Firstly, the integration of Minecraft during the practicum compelled novice teachers to rethink their instructional strategies and adopt creative, student-centered lesson designs that departed from conventional lecture-based approaches. This shift reflects the inherent nature of game-based learning (GBL), which demands the creation of interactive learning environments that actively involve students in constructing their own knowledge (Lameras et al., 2017). Teachers were required to design lessons that not only embedded scientific content but also leveraged the mechanics of gameplay—such as problem-solving challenges, exploration tasks, and collaborative building projects—to achieve learning outcomes. This aligns with the findings of Tawafak et al. (2020), who emphasized that GBL enhances pedagogical innovation by motivating teachers to experiment with new forms of lesson delivery.Furthermore, the planning process required teachers to synthesize pedagogical content knowledge (PCK) with technological competencies, reflecting the integration principles outlined in the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006). Within this framework, effective teaching with technology arises from the intersection of content, pedagogy, and technology knowledge, all of which were activated during the preparation of Minecraft-based lessons. By designing lessons that merged science content with interactive digital environments, teachers enhanced their capacity to select, adapt, and utilize technology in pedagogically meaningful ways, a skill essential for 21st-century teaching.

Moreover, exposure to Minecraft-based instruction during practicum likely accelerated the development of TPACK-G (Technological Pedagogical Content Knowledge for Games) competencies, a refinement of the TPACK framework that specifically focuses on game-based teaching (I-DiG STEM Team, 2022). According to this framework, teachers must understand how to align game mechanics with curricular objectives, manage gameplay within the classroom context, and scaffold students' learning experiences within a game environment. The novice teachers in this study demonstrated growth in these areas, suggesting that hands-on practicum experiences with educational games can serve as a powerful avenue for building both technological fluency and innovative pedagogical practices (De Smet, 2024).These findings also resonate with the work of Harris and Hofer (2011), who argued that authentic contexts for technology integration—such as practicum experiences—are crucial for enabling pre-service teachers to develop confidence and competence in using digital tools effectively. Similarly, Ellison and Evans (2016) reported that teachers using Minecraft experienced significant professional growth, particularly in creativity, problem-solving, and instructional flexibility. Thus, the incorporation of Minecraft not only enhanced lesson design but also acted as a catalyst for pedagogical transformation, preparing novice teachers to meet the demands of modern science education.

Secondly, the classroom observations provided compelling evidence that the integration of Minecraft significantly transformed the learning environment into an active and inquiry-based setting. Rather than following traditional didactic instruction, students were encouraged to explore, experiment, and collaborate within the virtual space. This shift is consistent with the constructivist learning paradigm, which posits that learners construct knowledge through active engagement and social interaction (Vygotsky, 1978; Piaget, 1970). In the observed lessons, students were not mere recipients of information; instead, they became co-creators of knowledge, generating hypotheses, testing solutions, and applying scientific concepts to in-game tasks.Teachers, in turn, assumed the role of facilitators and guides, providing scaffolding and feedback while allowing students to drive their own learning experiences. This instructional shift aligns with findings by Holmberg et al. (2019), who demonstrated that Minecraft-based activities promote authentic inquiry by allowing learners to engage in meaningful problem-solving within simulated environments. Such authentic learning experiences are known to enhance students' conceptual understanding and long-term retention of scientific ideas (Jonassen, 2014).

Moreover, the collaborative nature of Minecraft encouraged peer-to-peer learning and the development of 21st-century competencies such as teamwork, communication, and creativity. These observations are supported by studies such as Tan and Long (2023), which reported that Minecraft fosters cooperative learning and enhances classroom dynamics. The increased student engagement observed during Minecraft-based lessons also resonates with research by Smith et al. (2018), who found that sandbox games promote deep learning by motivating students to actively participate and connect theory with practice.Additionally, the use of Minecraft created a positive classroom climate, reducing behavioral issues often associated with disengagement in traditional lessons. Students were absorbed in their tasks, leading to fewer disruptions and increased focus. Similar findings were reported by Maria et al. (2025), who highlighted that game-based environments improve classroom management by maintaining high levels of learner interest and participation. Teachers observed that even students who were typically less engaged in conventional science classes showed renewed enthusiasm and persistence when learning was embedded in the Minecraft context.

The observed inquiry-based interactions also align with the Malaysia Education Blueprint (2013–2025), which promotes pedagogical shifts toward student-centered and inquiry-driven learning in STEM subjects. By enabling students to take ownership of their learning, Minecraft helped teachers fulfill this national policy directive while simultaneously enhancing their own instructional strategies. These findings underscore the potential of Minecraft not only as a technological tool but also as a pedagogical catalyst for implementing innovative, inquiry-oriented practices in science education.

Lastly, the motivational impact observed in this study aligns with self-determination theory (Deci & Ryan, 2000) and with findings by Ellison and Evans (2016), who reported increased teacher enthusiasm when integrating game-based pedagogies. Teachers' heightened confidence and willingness to experiment with emerging technologies reflect the transformative potential of GBL in teacher development. This also addresses national education priorities outlined in the Malaysia Education Blueprint (2013–2025), which emphasizes digital pedagogy, innovation, and professional growth in teacher training.

Collectively, the findings suggest that integrating Minecraft into practicum experiences not only benefits students but also serves as a powerful tool for teacher professional development. By fostering creativity, improving classroom practice, and boosting motivation, Minecraft aligns with both national policy goals and theoretical frameworks supporting technology-enhanced teaching. The study highlights the need for systematic incorporation of GBL training in teacher education programs to bridge the gap between policy aspirations and classroom realities.

Conclusion

The results of this study provide clear evidence that integrating Minecraft into science practicum experiences benefits novice teachers beyond the immediate classroom. The use of game-based learning fostered creative and student-centered lesson planning, encouraged a shift toward inquiry-driven instructional practices, and strengthened teachers' confidence and motivation to innovate. These outcomes not only align with global trends in technology-enhanced pedagogy but also support Malaysia's policy objectives for digital transformation in STEM education.

Overall, Minecraft served as both a technological and pedagogical catalyst, bridging theoretical training with practical classroom application. It empowered novice teachers to develop competencies aligned with frameworks such as TPACK and constructivist principles, equipping them to meet the challenges of 21st-century teaching. Future studies should consider longitudinal designs to evaluate sustained impacts over time and examine how systematic integration of game-based learning frameworks into teacher education programs can further enhance professional growth, instructional quality, and student outcomes.

References

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Chang, C. Y., Hsu, C. K., & Jong, M. S. Y. (2022). Designing game-based science lessons: Observation checklist and evaluation framework. *Educational Technology Research and Development, 70*(1), 89–108. https://doi.org/10.1007/s11423-021-10028-2

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). Sage Publications.

Danielson, C. (2013). *The framework for teaching evaluation instrument* (2013 ed.). The Danielson Group.

Jasper, M. A. (2005). Using reflective writing within research. *Journal of Research in Nursing, 10*(3), 247–260. https://doi.org/10.1177/174498710501000303

Deci, E. L., & Ryan, R. M. (2000). The “what” and “why” of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11*(4), 227–268.

De Smet, C. (2024). A qualitative evaluation study of introducing game-based learning methods during pre-service teachers’ internship. *Studies in Educational Evaluation, 83*, 101388.

Ellison, T. L., & Evans, J. N. (2016). Minecraft, teachers, parents, and learning: What they need to know and understand. *School Community Journal, 26*(2), 25–50

Holmberg, J., Lundström, U., & Granberg, C. (2019). Using Minecraft to foster inquiry-based learning in science classrooms. *International Journal of STEM Education, 6*(1), 1–15.

Jonassen, D. H. (2014). *Learning to solve problems: A handbook for designing problem-solving learning environments*. Routledge.

Kallio, H., Pietilä, A. M., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: Developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing, 72*(12), 2954–2965. https://doi.org/10.1111/jan.13031

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage Publications.

Lameras, P., Arnab, S., Dunwell, I., Stewart, C., Clarke, S., & Petridis, P. (2017). Essential features of serious games design in higher education: Linking learning attributes to game mechanics. *British Journal of Educational Technology, 48*(4), 972–994.

Lin, X., & Aloe, A. M. (2021). Meta-analysis of game-based learning: Effects on cognitive, social, and emotional outcomes. *Early Childhood Research Quarterly, 54*, 75–89.

Low, J. Y., Balamuralithara, B., & Yaacob, M. I. H. (2023). Game-based learning: Current practices and perceptions of secondary school physics teachers in Malaysia. *International*

Malaysia Education Blueprint 2013–2025. (2013). *Ministry of Education Malaysia*.

Maria, R. (2025). Minecraft’s implementation and impact on education. *ITM Web of Conferences, 64*, 02005.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017–1054.

Novak, M., & Krajcik, J. (2016). Using game-based simulations to promote conceptual change in science learning. *Journal of Research in Science Teaching, 53*(9), 1381–1401.

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research, 42*(5), 533–544. https://doi.org/10.1007/s10488-013-0528-y

Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (4th ed.). Sage Publications.

Piaget, J. (1970). *Science of education and the psychology of the child*. Orion Press.

Riduan, M. A., & Othman, Z. S. (2024). Examining challenges and strategies in implementing STEM education in Malaysian secondary schools: Perspectives of teachers and students. *Jurnal Intelek, 19*(2), 97–110. ResearchGate+1UiTM Institutional Repository+1

Smith, P. S., Hayes, M. L., & Shea, L. J. (2018). Using sandbox games to support inquiry-based learning in science. *International Journal of STEM Education, 5*(1), 1–15.

Tan, J. S., & Long, K. Y. (2023). Teachers' experiences of using Minecraft Education in primary school classrooms: Collaborative learning and engagement. *Irish Educational Studies, 42*(3), 1–15.

Tangkui, R. B., & Keong, T. C. (2023). The effect of Minecraft on learners' higher-order thinking skills in fractional problem-solving. *Anatolian Journal of Education, 8*(2), 1–20. https://doi.org/10.29333/aje.2023.821a ERIC+9e-aje.net+9European Proceedings+9

Tawafak, R. M., Alsalman, A. A., & Romli, M. A. (2020). The impact of game-based learning on students' engagement and motivation in learning computer programming. *Education and Information Technologies, 25*(6), 5085–5102.

Wallin, J., Thomasson, J., & Persson, A. (2023). Reflective diary writing in teacher education: Developing critical thinking and professional identity. *Teaching and Teacher Education, 125*, 104–130. https://doi.org/10.1016/j.tate.2023.104130

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.