Challenges of Technology Integration among Primary School Design and Technology (RBT) Teachers in Malaysia: A Qualitative Exploration

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DOI: https://doi.org/10.47772/IJRISS.2026.100500712

Received: 11 May 2026; Accepted: 16 May 2026; Published: 11 June 2026

ABSTRACT

This study investigates the challenges met by primary school Design and Technology (RBT) teachers in Malaysia during the early stages of integrating technology into teaching and learning practices. Although digital transformation has become an essential priority within contemporary education, the practical implementation of technology integration in primary classrooms remains uneven. Using an exploratory qualitative approach, semi-structured interviews were conducted with five RBT teachers in the Federal Territory of Kuala Lumpur to gain deeper insight into their professional experiences. The findings reveal that technology integration is influenced by multiple interconnected factors, including limited school support systems, insufficient infrastructure and teaching resources, restricted opportunities for practical professional development, and varying levels of teacher motivation and self-confidence. Teacher motivation was found to be closely shaped by the degree of recognition, autonomy, and organisational support provided within the school environment. In particular, non-option teachers frequently depended on self-initiated learning and collegial support to manage instructional expectations. The study demonstrates that the barriers to effective technology integration extend beyond technical limitations alone and are deeply connected to broader organisational and psychological conditions. These findings provide valuable insights into the real challenges experienced by RBT teachers while creating an important foundation for future initiatives to strengthen school support systems, enhance teacher competency, and promote sustainable technology integration practices within Malaysian primary education.

Keywords: Technology Integration, Design and Technology (RBT), Qualitative Inquiry, School Support Systems, Teacher Motivation

INTRODUCTION

Technology integration in 21st-century education has become a central pillar of global pedagogical transformation, emphasising digital skills, innovation, and problem-based learning. In Malaysia, the Design and Technology (RBT) subject serves as an important platform for developing students' creativity, analytical thinking, and design-oriented skills through hands-on and project-based learning approaches (Ismail et al., 2022; Yusof et al., 2023). However, the effectiveness of RBT implementation remains dependent on the level of school support, teacher competency, and the availability of adequate technological infrastructure. According to the KSSR (Semakan 2017) curriculum review report, several critical issues persist including excessive curriculum content, limited instructional time, and insufficient teacher training, particularly in subjects such as Science, Mathematics, and RBT. Although initiatives such as the Modul Bimbingan (MOBIM) have been introduced to strengthen curriculum implementation, challenges related to school support and teacher competency in RBT remain significant (MOE, 2022).

School support has been identified as a key factor influencing teachers' ability to integrate technology in teaching and learning (Venkatesh et al., 2003; Teo, 2014; Razak et al., 2023). According to the Unified Theory of Acceptance and Use of Technology (UTAUT), facilitating conditions such as school leadership, technological infrastructure, continuous professional development, and a supportive collaborative culture are essential factors that influence teachers' actual technology integration practices (Venkatesh, Thong, & Xu, 2012; Kamble, 2022).

Schools with strong support systems not only provide access to ICT resources but also foster an environment that encourages pedagogical innovation and experimentation (Admiraal et al., 2017). In RBT education, strong school support plays an important role in helping teachers effectively integrate technological elements such as robotics, micro:bit, and basic programming in line with current curriculum requirements (Ting & Abdul Karim, 2024).

However, previous studies indicate that systematic school support remains insufficient to fully support teachers in implementing technology integration. Limited ICT facilities, inconsistent technical support, and inadequate professional training continue to hinder effective RBT teaching (Ertmer, 1999; Yunus et al., 2022). As a consequence, teachers' technology integration competency remains inconsistent, particularly in applying digital tools and programming elements within classroom practice (Chua & Jamil, 2012; Hudin, 2023). Although teachers demonstrate interest in digital innovation, their motivation and capability are often constrained by the lack of continuous guidance and supportive school culture (Skaalvik & Skaalvik, 2010; Abdullah et al., 2020).

Ertmer and Ottenbreit-Leftwich (2010) argue that technology-based pedagogical change requires more than technical skills. It also involves teacher beliefs, leadership support, and a working environment that encourages experimentation. Tondeur et al. (2018) found that strong organisational support through professional learning communities (PLC) enhances teachers' competency in technology integration.

Furthermore, Granić and Marangunić (2022) highlight that successful adoption of educational technology requires the integration of motivation, sustained professional development, and reflective practice. These findings suggest that the relationship between school support and technology integration competency requires further exploration, particularly in understanding how these factors interact in real classroom contexts. In response to these challenges, this study seeks to examine the role of school support systems in driving and strengthening technology integration competency among primary school RBT teachers. Specifically, the study seeks to (i) identify the forms of school support that influence teachers' ability to integrate technology effectively, and (ii) examine teachers' competency levels based on the support received. A qualitative approach is employed to gain in-depth insights into the experiences of both option and non-option RBT teachers in implementing technology-based teaching practices.

This study is significant for multiple stakeholders. The findings provide the Ministry of Education Malaysia (KPM) with valuable evidence to evaluate the effectiveness of current digital education policies and support the development of more targeted, needs-based teacher training initiatives. The study strengthens educational community awareness of the critical role school support plays in achieving meaningful technology integration. The findings may also inform industry stakeholders in developing relevant training modules and infrastructure that align with RBT curriculum requirements (Papagiannopoulou et al., 2025). In terms of academic contribution, this study extends existing literature by contextualising the interaction between school support and teacher competency within the Malaysian primary education setting, particularly in relation to TPACK and UTAUT frameworks (Mishra & Koehler, 2006; Chai et al., 2013).

This study focuses on primary school RBT teachers, including both option and non-option teachers, within the Federal Territory of Kuala Lumpur. It examines teachers' experiences in relation to various forms of school support, including professional development, peer collaboration, ICT facilities, and administrative guidance. This context is particularly relevant as it represents diverse school environments with varying levels of technological readiness, providing a realistic perspective on the challenges of technology integration in urban primary schools.

LITERATURE REVIEW

Introduction to the Literature Review

Technology integration in education has become an essential element in developing 21st-century skills, in line creativity. In Malaysia, the implementation of the revised Kurikulum Standard Sekolah Rendah (KSSR Semakan 2017) for the Design and Technology (RBT) subject requires teachers to incorporate design, engineering, and programming skills together with digital tools such as micro:bit and mBlock into their teaching practices (MOE,

2022). However, findings from the Sesi Libat Urus (SLU) report indicate persistent issues, including an overloaded curriculum, insufficient instructional time, limited teacher mastery of new content, and inadequate training, particularly in RBT (MOE, 2022).

School support serves as a significant driving force that shapes teachers' capability and confidence in implementing technology integration effectively (Chiu, 2022; Cabellos et al., 2024). Despite its widely recognised importance, the practical role of school support in strengthening teacher competency remains underexplored, particularly within primary school RBT education. This study therefore examines how school support functions as a catalyst in enhancing technology integration competency among primary school RBT teachers in the Federal Territory of Kuala Lumpur.

Key Themes and Topics

Concept of School Support in Technology Integration

According to the Unified Theory of Acceptance and Use of Technology, facilitating conditions refer to the extent to which individuals believe that organisational infrastructure supports technology use (Venkatesh et al., 2003; Venkatesh, Thong & Xu, 2012). In school contexts, this includes ICT facilities, professional development opportunities, proactive leadership, and collaborative cultures that encourage innovative teaching practices (Teo, 2014; Kamble, 2022). Studies by Admiraal et al. (2017) and Ifenthaler & Schweinbenz (2013) indicate that teachers who receive systematic support from administrators and peers are more capable of applying technology meaningfully in teaching.

However, existing literature tends to conceptualise school support primarily in terms of availability rather than effectiveness. While Granić and Marangunić (2022) emphasise the need for alignment between institutional policies and teachers' needs, there remains a limited empirical explanation of how such alignment translates into sustained classroom practice. Similarly, UNESCO (2022) highlights organisational factors such as internal training and professional learning communities (PLC), yet does not sufficiently explain how these structures influence actual teaching behaviour. This suggests that school support is often treated as a passive enabler rather than an active mechanism influencing competency development.

Teacher Competency in Technology Integration (TPACK)

The Technological Pedagogical Content Knowledge introduced by Mishra and Koehler (2006) serves as a foundational model in understanding teachers' ability to integrate technology effectively. The model integrates technological, pedagogical, and content knowledge, enabling teachers to design meaningful and innovative learning experiences. Studies have consistently shown that strong TPACK competency enhances the quality of technology-based teaching practices (Chua & Jamil, 2012; Tondeur et al., 2018).

Despite ongoing curriculum developments, local studies show that many RBT teachers still encounter difficulties in effectively mastering both technological and pedagogical integration within their teaching practices (Yunus et al., 2022). Even with the introduction of instructional modules such as Let's Explore Micro:bit (LEM), improvements in competency remain inconsistent, particularly in translating technical skills into effective pedagogical practices (Ting & Abdul Karim, 2024). Hudin (2023) further highlights that limited training exposure and curriculum constraints hinder teachers' ability to implement programming activities effectively.

These findings suggest that TPACK, while theoretically robust, does not fully account for contextual limitations. Competency development cannot be understood solely at the individual level, as it is significantly influenced by organisational support and environmental conditions.

Role of Motivation and Organisational Support (SDT)

The Self-Determination Theory (SDT) explains teacher motivation through the fulfilment of three basic needs: autonomy, competence, and relatedness (Deci & Ryan, 1985, 2000). Research by Skaalvik and Skaalvik (2010) demonstrates that supportive school environments that provide autonomy and recognition enhance teachers'

confidence and willingness to adopt innovative practices. Nevertheless, the relationship between motivation and actual implementation remains complex. Abdullah et al. (2020) found that even when teachers demonstrate intrinsic motivation, their ability to integrate technology is often constrained by organisational limitations. This indicates that motivation alone is insufficient to drive behavioural change without adequate structural support. Consequently, motivation should be understood as an interacting factor shaped by institutional conditions rather than an independent predictor of technology integration.

Context of RBT Implementation in Malaysian Primary Schools

The RBT subject in Malaysian primary schools is designed to develop students' design thinking, problem-solving skills, and technological literacy. SLU findings reveal that RBT is among the subjects most significantly impacted by limitations in teacher training and insufficient instructional time, which continue to affect effective curriculum implementation (MOE, 2022). Ismail et al. (2022) reported that project-based learning approaches are not fully implemented due to teachers' lack of confidence in using digital tools and design software.Yusof et al. (2023) found that block-based programming enhances students' understanding of robotics projects, yet its effectiveness is highly dependent on teachers' competency. Papagiannopoulou et al. (2025) further reported that primary school teachers' readiness to implement robotics and automation remains at a moderate level, especially among non-option teachers. These findings emphasise the need to further explore the role of school support as an essential factor in strengthening teacher competency within this educational context.

Research Gaps

Three key gaps are identified in the literature. First, studies on technology integration in primary RBT education remain limited, despite its importance in developing students' technological literacy (Yusof et al., 2023; Hudin, 2023).Second, existing research is predominantly quantitative, focusing on measurable constructs while lacking in-depth exploration of teachers' lived experiences and contextual realities (Ertmer & Ottenbreit-Leftwich, 2010; Admiraal et al., 2017).Third, the interaction between school support, teacher motivation, and competency has not been sufficiently examined as an integrated framework. Most studies treat these variables independently, resulting in a fragmented understanding of technology integration practices.

Conceptual Framework Development

Based on the literature, the conceptual framework integrates three key dimensions:

1. **School Support (UTAUT – Facilitating Conditions):** Includes leadership support, ICT infrastructure, digital guidance, and continuous professional development (Teo, 2014; Kamble, 2022).

2. **Technology Integration Competency (TPACK):** Refers to teachers' ability to integrate technological, pedagogical, and content knowledge in RBT teaching (Mishra & Koehler, 2006; Tondeur et al., 2018).

3. **Teacher Motivation (SDT):** Functions as a psychological mediator linking school support to teachers' ability to innovate and implement technology (Ryan & Deci, 2020).

Overall, the framework posits that school support influences teacher motivation, which subsequently strengthens technology integration competency. UTAUT provides the organisational foundation, TPACK measures competency, and SDT explains motivational dynamics within the RBT teaching ecosystem.

Previous studies consistently suggest that strong school support is positively associated with more effective technology integration in educational practice.Georgiou et al. (2023) and Antonietti et al. (2022) found that teachers' perceptions of facilities and training significantly influence their readiness to adopt new technologies. However, contrasting findings by Ertmer (1999) and Voogt et al. (2013) suggest that the presence of infrastructure alone does not guarantee effective implementation, as teacher beliefs and self-efficacy remain critical barriers.Additionally, Willermark (2018) and Çam et al. (2024) emphasise that TPACK development requires sustained professional development rather than one-off interventions. In Malaysia, Chan & Mohamad (2019) and Yunus et al. (2022) highlight that existing training programmes are often theoretical and lack practical

application, limiting their effectiveness. These findings reinforce the notion that both structural and psychological factors must be considered simultaneously.

The literature indicates that effective technology integration in RBT is influenced by the interaction between external factors (school support) and internal factors (teacher motivation and competency). Although policy initiatives such as MOBIM (MOE, 2022) have been introduced, implementation remains inconsistent, particularly among non-option teachers. This study addresses these limitations by examining school support as a catalytic mechanism that strengthens teacher competency through the integration of UTAUT, TPACK, and SDT perspectives. This study offers a broader understanding of technology integration in Malaysian primary education while generating meaningful insights that can support the enhancement and sustainability of school-based support systems.

METHODOLOGY

This study adopts a qualitative approach to explore in depth the role of school support systems in shaping the technology integration competency of primary school Design and Technology (RBT) teachers. The qualitative approach is appropriate as it enables the study to examine social phenomena within their natural context through the perspectives of participants directly involved in the issue under investigation. As highlighted by Creswell (2016), qualitative research emphasises the meanings constructed by individuals rather than numerical measurement. This approach is therefore suitable for capturing teachers' experiences, perceptions, and interpretations of school support and its influence on their competency in technology-based teaching.

A total of five participants, consisting of both option and non-option RBT teachers from schools under the Federal Territory of Kuala Lumpur (JPWPKL) were interviewed. The interviews aimed to generate rich, narrative data aligned with the two primary research objectives: (i) to identify forms of school support that influence teachers' ability to integrate technology, and (ii) to examine the level of technology integration competency based on the support received.

Research Design: Basic Qualitative Inquiry

The study employs a Basic Qualitative Inquiry design as outlined by Merriam and Tisdell (2016) and supported by Leavy (2017). This design is appropriate when the objective is to understand how individuals interpret their experiences within a social context without being confined to specific qualitative traditions such as phenomenology, ethnography, or case study. According to Patton (2015), this design is grounded in constructivist assumptions in which meaning is developed through human interaction in real-life settings. The selection of this design aligns with the study's objective, which is to understand how and why school support functions as a substance enhancing teachers' competency in technology integration. Yin (2018) highlights that this type of inquiry prioritises in-depth understanding rather than broad generalisation, making it particularly suitable for exploring the relationship between organisational factors, social support, and teacher competency.

Data Collection Methods

The primary data collection method employed in this study is semi-structured interviews. According to Kothari (2004), interviews enable researchers to obtain rich, relevant, and contextually grounded information directly from participants. The interview protocol was developed based on the research objectives and validated by two subject matter experts to ensure content validity. The interview questions covered areas such as forms of school support, professional training, access to ICT facilities and teachers' perceptions of the effectiveness of such support.

Semi-structured interviews were selected as they provide a balance between structure and flexibility. As noted by Creswell (2016), this approach allows researchers to adapt questions according to the flow of conversation while encouraging in-depth responses. In addition, informal observations were conducted during school visits to assess the physical environment including RBT facilities, the use of digital tools, and the level of administrative support. Field notes were recorded to document observations and the researcher's reflections, serving as supplementary data for analysis.

Sampling Strategy

This study used purposive sampling to select participants who were directly related to the research focus. The participants were primary school RBT teachers under JPWPKL who had at least two years of teaching experience and had taught RBT lessons involving the use of technology. The selection was guided by several criteria. First, the participants had to be primary school teachers currently teaching RBT in government schools. Second, they needed to have experience in conducting technology-based RBT lessons. Third, they had at least two years of teaching experience. The selection also included both option and non-option RBT teachers to reflect different teaching backgrounds. Teachers who were not teaching RBT were not included in this study.

Five teachers were selected to participate in the study, representing both option and non-option backgrounds. Although the number of participants was limited, it was considered suitable for an exploratory qualitative study because the aim was to gain detailed insights into teachers' classroom experiences rather than to generalise the findings statistically (Creswell, 2016; Patton, 2015; Merriam & Tisdell, 2016). The small number of participants is also acknowledged as a study limitation; therefore, the findings should be interpreted within the specific context of the selected schools in Kuala Lumpur.

Data Analysis

Data were analysed manually using coding and thematic analysis as proposed by Braun and Clarke (2006). The analysis began with the verbatim transcription of interview recordings, followed by repeated reading of the transcripts to gain an overall understanding of the participants' responses. The analysis then moved to open coding, where key statements related to school support, infrastructure, professional development, teacher motivation, confidence, and technology integration practices were identified from the interview data. These codes were later grouped into broader categories and refined into main themes and subthemes aligned with the research objectives. The coding process was carried out manually using Microsoft Word to support close engagement with the data and to document the development of codes, categories, and themes throughout the analysis. The final themes were compared across participants to identify recurring patterns, similarities, and differences in their classroom experiences. Direct quotations from participants were used to support the themes and ensure that the findings remained grounded in the data. This process is consistent with thematic analysis, which enables researchers to identify patterns and underlying meanings within participants' narratives (Braun & Clarke, 2006; Yin, 2018).

Ethical Considerations

This study adhered to ethical principles in educational research as outlined by Creswell (2016) and Leavy (2017). Approval to conduct the study was obtained from the relevant educational authority, with permission from the school administrators involved. All teacher participants were informed about the purpose of the study before the interviews were conducted, and their participation was voluntary.

Participant confidentiality was protected through the use of pseudonyms, and all data were securely stored in digital files accessible only to the researcher. The study did not involve pupils' personal information or any audio/video recording of pupils. These procedures were applied to protect participants' confidentiality and to maintain ethical integrity throughout the research process (Creswell, 2016; Leavy, 2017; Kothari, 2004).

Data Validity and Reliability

In qualitative research, validity and reliability are usually discussed via the concept of trustworthiness. Trustworthiness reflects the extent to which the research process is systematic and the findings are credible, consistent, and grounded in participants' actual experiences. In this study, trustworthiness was strengthened through four main aspects: credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985; Merriam & Tisdell, 2016; Creswell & Poth, 2018).

Credibility was supported through member checking, where participants were allowed to review selected interpretations of their interview responses. This step helped ensure that the findings reflected the meanings

intended by the participants. Triangulation was carried out by comparing participants' interview responses with field notes and informal observations from school visits, particularly on ICT facilities, RBT equipment, classroom resources, and administrative support.

Transferability was addressed by providing clear descriptions of the research context, participant backgrounds, teaching experience, and school districts involved in the study. Dependability was maintained through systematic documentation of the research process, including interview procedures, coding decisions, category development, and theme refinement. Confirmability was strengthened through an audit trail and researcher reflection to reduce bias during data interpretation. These procedures helped ensure that the findings were firmly linked to the data, participants' narratives, and the themes developed during analysis (Nowell et al., 2017; Creswell & Poth, 2018).

CONCLUSION OF METHODOLOGY

Overall, the Basic Qualitative Inquiry design helped this study examine RBT teachers' experiences with school support systems and technology integration in a more detailed and context-sensitive way. The use of semi-structured interviews, field notes, purposive sampling, thematic analysis, and trustworthiness procedures strengthened the methodological rigour of the study (Merriam & Tisdell, 2016; Patton, 2015; Braun & Clarke, 2006; Lincoln & Guba, 1985).

This approach was suitable because the study sought to understand how external factors, such as school support, infrastructure, and professional development, interact with internal factors, including teacher competency, motivation, and confidence. Although the findings are shaped by the specific context of the selected schools, they still offer useful insights into the realities of technology integration in primary school RBT classrooms and may serve as a basis for improving school support systems in Malaysian primary education (Creswell & Poth, 2018; Yin, 2018).

Table 1: Profile of Study Participants.

Participant Code	Gender	Specialisation	Teaching Experience	School District	Background
P1	Female	Non - option	6 years	Pudu	Mathematics background; 3 years of experience teaching RBT
P2	Male	RBT Option	10 Years	Keramat	RBT specialist, actively involved in the school robotics club
P3	Female	Non - option	8 Years	Bangsar	Science Teacher, recently took over RBT (2 years)
P4	Male	RBT Option	12 Years	Pudu	Former district – level RBT Trainer (JU)
P5	Female	RBT Option	9 Years	Sentul	RBT specialist, expertise in digital mini design projects.

The table summarizes the participants' demographic characteristics, teaching experience, and professional background relevant to RBT instruction.

Question 1: School Support

Participant P1 explained that school support was present but not comprehensive, particularly in terms of resources:

"Mmm... sekolah saya ni... sokongan dia ada laa tapi tak menyeluruh sangat. Macam laptop ada... tapi kongsi. Kadang-kadang kalau nak guna makmal komputer tu, kena booking awal… sebab ramai guna. Tapi ehh...pentadbir okey laa, dia bagi galakan cuma dari segi alat dan bahan tu... banyak guna duit sendiri jugak." "My school does provide some support, but it is not very comprehensive. Laptops are available but need to be shared, and access to the computer lab often requires prior booking. The principal is supportive in terms of encouragement, but for tools and materials, I often have to use my own money." (P1)

Participant P2 highlighted strong leadership support but limitations in technical staffing:

“Aa... sekolah saya agak baik sokongan dia. Bila saya cadang buat bengkel micro:bit, terus PK1 setuju dan bantu cari bajet PIBG. Saya rasa, kalau pentadbir faham konsep RBT ni,senang kerja kita. Cuma kadang tu... staf teknikal takda, ICT tak cukup, tu yang slow bila komputer rosak.”
“My school provides quite good support. When I proposed a micro:bit workshop, the assistant principal supported it and helped secure funding. However, there is a lack of ICT and technical staff which slows down repairs.” (P2)

Participant P3 described reliance on self-learning due to a lack of resources:

“Ehhh... saya bukan opsyen kan, so saya banyak belajar sendiri. Sekolah bagi sokongan dari segi moral je la. Kawan-kawan pun banyak tolong… tapi peralatan RBT tu tak cukup sangat. Haa... jadi saya guna kreativiti sendirilah guna barang terpakai.”
“As a non-option teacher, I rely on self-learning. The school provides moral support, but equipment is insufficient, so I use my own creativity with recycled materials.” (P3)

Participant P4 emphasised inconsistency in support systems:

“Saya rasa sokongan sekolah saya okey, tapi kalau nak kata mantap tu belum lagi. Pentadbir bagi ruang… tapi kadang sistem kita ni cepat semangat, lepas tu senyap. Saya harap ada sistem PLC yang berterusan, bukan bermusim.”
“The support is acceptable, but not yet strong. Initiatives tend to fade over time, and a continuous PLC system is needed.” (P4)

Participant P5 highlighted strong digital leadership but varying teacher readiness:

“Mmm... sekolah saya ni kira bertuah sebab pentadbir memang jenis suka benda digital. Dia bagi saya handle projek ‘Digital Classroom’. So... bila saya nak guna tablet,mikrobit, printer 3D tu semua, sekolah terus bantu mohon peruntukan khas. Tapi kadang... cikgu lain tak ramai yang nak join sebab tak yakin guna.”
“I am fortunate to have a principal who supports digital initiatives. However, some teachers are still hesitant due to lack of confidence.” (P5)

Question 2: Impact of School Support

Participant P1 explained the effect of limited support on motivation and practice:

“Kalau ada sokongan… senang la kerja. Tapi bila kurang, kita jadi kurang semangat. Mmm... macam nak buat projek coding pun terbantut sebab laptop sekolah slow. Kadang saya guna laptop sendiri… nak bagi murid belajar juga.”
“When support is available, work becomes easier. Without it, motivation decreases, and I sometimes use my own laptop due to technical limitations.” (P1)

Participant P2 highlighted the role of recognition and opportunity:

“Saya rasa besar kesannya. Bila sekolah bagi peluang, kita rasa dihargai. Macam baru ni saya diberi masa khas buat bengkel robotik, murid pun semangat. Kalau sekolah tak bagi ruang, semua tu jadi teori je.”
“The impact is significant. When opportunities are given, we feel appreciated, and students become more engaged.” (P2)

Participant P3 reflected on confidence and training:

“Sokongan tu penting laa. Tapi saya pun kadang rasa rendah diri sebab tak mahir. Bila sekolah bagi latihan ICT tu, saya rasa lebih berani nak cuba. Tapi latihan tak kerap sangat, tu yang lambat.”

"Support is important, but limited skills affect my confidence. Training helps, but it is not frequent enough." (P3)

Participant P4 linked support to motivation:

"Ehhh, sokongan ni bagi kesan pada sikap kita. Kalau pentadbir selalu turun padang tengok PdP, bagi pujian, saya rasa lebih termotivasi. Tapi kalau semua diserah pada guru saja, lama-lama hilang semangat la." "Support influences our attitude. Recognition increases motivation, but lack of involvement reduces it over time." (P4)

Participant P5 described how support enables innovation:

"Sokongan sekolah memang penting. Saya dulu pun banyak idea tapi takut nak buat sebab tak tahu nak mohon bajet. Bila sekolah bantu, saya berani try guna macam – macam termasuklah mikrobit, 3D

printer dalam projek RBT. Hasilnya, murid pun excited."
"School support builds confidence and enables innovation, which increases student engagement." (P5)

Question 3: Training and Facilities

Participant P1 emphasised hands-on learning:

"Latihan… mmm, kalau boleh biar hands-on la. Kadang kursus online tu susah nak ikut. Saya suka bila ada bengkel amali, boleh terus guna peralatan RBT tu."

"Hands-on training is more effective, as online courses are difficult to follow." (P1)

Participant P2 highlighted PLC and constraints:

"Saya suka bila KPM buat kursus PLC RBT sebab boleh kongsi idea dengan cikgu lain. Tapi nak minta cuti pergi kursus pun susah kadang. Kalau sekolah ada latihan dalaman pun bagus."

"PLC-based training is beneficial, but time constraints limit participation." (P2)

Participant P3 emphasised mentorship:

"Ehhh, saya rasa yang paling membantu bila cikgu senior ajar terus. Macam mentor la. Dia tunjuk cara guna pengaturcaraan, atau Tinkercad, baru saya faham. Kalau baca nota je, tak masuk otak."

"Mentorship is the most effective, as direct guidance improves understanding." (P3)

Participant P4 highlighted structured training needs:

"Saya pernah pergi bengkel RBT di IPG, memang best sebab semua tunjuk cara buat model. Tapi jarang la dapat pergi. Kalau ada PLC berkala, saya sanggup join tiap bulan."

"Workshops are useful, but opportunities are limited; continuous PLC is needed." (P4)

Participant P5 emphasised advanced training and knowledge sharing:

"Kalau saya, kursus 3D design ,kursus mikrobit tu memang membantu. Lepas tu sekolah bagi saya ajar cikgu lain pula. Jadi kita bukan je belajar, tapi share balik. Itu yang buat saya ingat."

"Advanced training and teaching others reinforce learning." (P5)

Question 4: Strengths and Gaps in Support

Participant P1 highlighted time vs equipment issues:

"Yang membantu... hmm... kalau pentadbir bagi masa khas untuk RBT pun dah bagus. Tapi yang kurang… alat. Banyak sangat kena kongsi."

"Time allocation helps, but equipment sharing remains a challenge." (P1)

Participant P2 emphasised funding vs technical gaps:

"Yang paling membantu bila sekolah bagi bajet tahunan khas RBT. Tapi yang kurang, kadang banyak tak cukup. Bila komputer rosak, tunggu seminggu pun belum tentu siap."

"Funding helps, but lack of technical support delays implementation." (P2)

Participant P3 highlighted peer support limitations:

"Saya rasa yang membantu bila cikgu-cikgu lain sudi bantu. Tapi kurangnya, tiada guru opsyen RBT kat sekolah saya, jadi susah nak rujuk."
"Peer support helps, but lack of specialised teachers limits guidance." (P3)

Participant P4 emphasised structure vs autonomy:

"Yang paling membantu… sekolah bagi kebebasan guna apa saja platform. Tapi yang kurang, tak ada sistem rekod latihan atau PLC formal. Semua ad-hoc je."

"Autonomy is helpful, but lack of structured systems weakens sustainability." (P4)

Participant P5 highlighted recognition vs maintenance issues:

"Saya suka bila sekolah anjur pameran hasil projek RBT. Itu motivasi untuk murid dan guru. Tapi kekurangan utama masih pada penyelenggaraan alat – cepat rosak, lambat ganti."

"Recognition motivates teachers and students, but maintenance remains a major issue." (P5)

Table 2: Summary of Main Themes and Subthemes

Main Theme	Subthemes (Codes)	Source (Participants)
School Support	Administrative moral support, Digital leadership, PIBG funding, Teacher autonomy	P1–P5
Infrastructure Constraints	Limited ICT facilities, Insufficient equipment, Inadequate technical support	P1, P2, P5
Professional Development and Training	Hands-on training, Professional Learning Community (PLC), Mentorship, IPG training	P1–P4
Teacher Motivation and Confidence	Innovation drive, Moral recognition, Willingness to experiment	P2, P4, P5
Non-Option Teacher Challenges	Lack of training, Self-adaptation, Dependence on colleagues	P1, P3

The table summarises the key themes derived from the coding process, highlighting the interconnected factors influencing teachers' technology integration practices in RBT classrooms.

Supporting Evidence

Theme 1: School Leadership and Organisational Support

Most participants emphasised leadership as the most critical factor in the implementation of technology-based RBT. As explained by (P2):

"Aa... sekolah saya agak baik sokongan dia. Bila saya cadang buat bengkel micro:bit, terus PK1 setuju dan bantu cari bajet PIBG. Saya rasa, kalau pentadbir faham konsep RBT ni, senang kerja kita."
"My school provides strong support. When I proposed a micro:bit workshop, the assistant principal immediately agreed and helped secure funding through the PIBG. When school leaders understand the RBT context, implementation becomes much smoother." (P2)

This statement illustrates that proactive leadership, combined with an understanding of subject-specific needs, accelerates the implementation of technology-based initiatives. Similarly, (P5) added:

"Mmm... sekolah saya ni kira bertuah sebab pentadbir memang jenis suka benda digital. Dia bagi saya handle projek 'Digital Classroom'... sekolah terus bantu mohon peruntukan khas."
"I consider my school fortunate because the principal strongly supports digital initiatives. I was entrusted to lead the 'Digital Classroom' project, and the school actively facilitated funding applications." (P5)

These responses indicate that administrative support extends beyond moral encouragement to include financial resources and leadership opportunities, aligning with the concept of facilitating conditions in the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003).

Theme 2: Infrastructure and Resource Constraints

Limited ICT facilities and teaching tools emerged consistently across the interviews. (P1) stated:

"Mmm... laptop ada laa tapi kongsi. Kadang-kadang nak guna makmal komputer kena booking awal. Banyak juga alat guna duit sendiri."

"Laptops are available, but they have to be shared. Access to the computer lab requires early booking, and I often rely on personal funds for teaching materials." (P1)

Similarly, (P3) explained:

"Ehhh... saya bukan opsyen kan, jadi banyak belajar sendiri. Tapi peralatan RBT tu tak cukup sangat... saya guna barang terpakai."

"As a non-option teacher, I rely heavily on self-learning. However, RBT equipment is insufficient, so I use recycled materials as alternatives." (P3)

These findings suggest that inadequate infrastructure compels teachers to adopt compensatory strategies, such as improvisation and personal resource use, which may limit the effectiveness of technology-based instruction. This supports Admiraal et al. (2017), who identified technical constraints as a major barrier to effective ICT integration in schools.

Theme 3: Professional Training and Knowledge Sharing

All participants highlighted the importance of hands-on training and continuous guidance. (P1) noted:

"Latihan... mmm, kalau boleh biar hands-on la. Kursus online tu susah nak ikut."

"Training should ideally be hands-on, as online courses are often difficult to follow." (P1)

P3 further elaborated:

"Ehhh, saya rasa yang paling membantu bila cikgu senior ajar terus. Macam mentor la. Dia tunjuk cara guna pengaturcaraan, atau Tinkercad, baru saya faham."

"The most effective approach is direct guidance from experienced teachers. Mentorship helps me understand tools like programming and Tinkercad more effectively." (P3)

Additionally, (P4) suggested:

"Kalau ada PLC berkala, saya sanggup join tiap bulan.""If there were regular PLC sessions, I would be willing to participate every month." (P4)

These responses indicate that practice-based, collaborative learning approaches are more effective than purely theoretical training. This aligns with Tondeur et al. (2018), who emphasised the importance of sustained professional development in enhancing teachers' technology integration competency.

Theme 4: Teacher Motivation and Autonomy

Moral support, recognition, and autonomy were found to influence teacher motivation significantly. (P4) explained:

"Ehhh, sokongan ni bagi kesan pada sikap kita. Kalau pentadbir selalu turun padang tengok PdP, bagi pujian, saya rasa lebih termotivasi."

"Support influences our attitude. When administrators observe lessons and provide recognition, it increases motivation." (P4)

Similarly, (P5) stated:

"Saya dulu pun banyak idea tapi takut nak buat sebab tak tahu nak mohon bajet. Bila sekolah bantu, saya berani try guna mikrobit, 3D printer. Murid pun excited." "I had many ideas but lacked confidence to implement them due to funding uncertainty. With school support, I became confident to use a mikrobit , 3D printer, and students were more engaged." (P5)

These findings demonstrate that teacher motivation is strengthened through recognition and autonomy, consistent with Self-Determination Theory (Deci & Ryan, 1985), which emphasises autonomy, competence, and social support as key drivers of intrinsic motivation.

DISCUSSION OF KEY FINDINGS

The findings suggest that strong school support functions as a primary substance in developing RBT teachers' competency in technology integration. Schools with digital leadership and an innovation-oriented culture are more likely to produce teachers who are confident and willing to experiment with new technologies.

These findings reinforce previous studies by Teo (2014) and Granić and Marangunić (2022), which highlight the positive relationship between organisational leadership and teachers' technology acceptance. In the Malaysian context, the results are consistent with Yunus et al. (2022) and Ismail et al. (2022), who found that organisational factors and professional training directly influence the implementation of technology-based RBT.

Furthermore, the study highlights differences between option and non-option teachers. Non-option teachers tend to compensate for limited formal training through self-directed learning and peer support, reflecting adaptability and resilience. However, they still require structured guidance and systematic training to strengthen both technical and pedagogical competencies, particularly within the TPACK framework.

Unexpected or Contradictory Findings

Interestingly, while most participants emphasised the importance of administrative support, there were instances where the availability of physical resources did not guarantee effective implementation. For example, Cikgu P5 noted that despite having access to advanced digital tools, some teachers remained reluctant to use them due to a lack of confidence.This finding suggests that internal factors such as motivation, attitude, and self-efficacy play an equally important role alongside external support. It challenges the assumption that infrastructure is the primary barrier, instead highlighting the significance of psychological readiness among teachers. This aligns with Bandura (2002) and Skaalvik and Skaalvik (2010), who emphasised the role of self-efficacy in influencing teaching practices and behaviour.

Limitations of the Study

This study has several limitations that should be considered when interpreting the findings. First, the study involved five RBT teachers from primary schools in the Federal Territory of Kuala Lumpur. Due to the limited number of participants and the specific study context, the findings should be interpreted within the context of the selected participants and schools. However, the findings remain valuable in providing in-depth insights into

the challenges experienced by RBT teachers during the early stage of technology integration in primary school classrooms.

Second, the study focused on teachers' perspectives. While teachers play a central role in classroom implementation, technology integration is also shaped by the views and decisions of other stakeholders, such as school leaders, students, curriculum officers, and policymakers. Therefore, the findings may not fully capture the broader institutional, administrative, and policy-related factors that influence technology integration in RBT education. These limitations do not lessen the relevance of the findings, but they indicate that the results should be interpreted carefully within the qualitative and contextual nature of the study.

Future Research

Future research could extend this study by involving a larger number of RBT teachers from different states in Malaysia. A broader group of participants would provide a broader view of how technology integration challenges may vary according to school location, infrastructure readiness, teacher background, and the level of administrative support provided by schools. Future studies could also compare urban and rural school contexts for understanding how different school environments influence the implementation of technology-based RBT teaching.

In addition, future research should consider the perspectives of other stakeholders, including school leaders, students, curriculum officers, and policymakers. Their views may offer a more complete understanding of the support systems needed to strengthen technology integration in primary school RBT education. A mixed-methods approach could also be considered in future studies, as it would allow researchers to combine teachers' lived experiences with quantitative evidence related to teacher competency, motivation, school support, and actual technology integration practices.

FINDINGS

This study underscores the pivotal role of school support systems as a key substance in strengthening the technology integration competency of Design and Technology (RBT) teachers in primary schools. The findings of this study were generated through in-depth interviews with five RBT teachers and are organised into four interconnected themes such as school leadership and organisational support, infrastructure and resource constraints, professional training, and teacher motivation and autonomy. Together, these elements form a dynamic school ecosystem that shapes the effectiveness of technology-based teaching and learning.The study demonstrates that while access to facilities and professional development opportunities is essential, these factors alone are insufficient to ensure successful implementation. Instead, psychological dimensions and organisational culture emerge as decisive influences. Teachers who experience supportive leadership, recognition, and autonomy are more likely to demonstrate confidence, initiative, and sustained engagement in integrating technology into their classroom practices.

Importantly, the findings highlight the need for a balanced support structure. Effective improvement strategies should integrate three key dimensions: physical support (adequate equipment and financial resources), professional support (continuous training and Professional Learning Communities), and emotional support (recognition, encouragement, and teacher autonomy). This integrated approach ensures that technology integration is not implemented in isolation, but embedded within a supportive and sustainable educational environment.The findings contribute to the understanding of established frameworks. The results align with the Unified Theory of Acceptance and Use of Technology by reinforcing the importance of facilitating conditions in influencing technology adoption (Venkatesh et al., 2003). However, the results suggest the importance of technological pedagogical content knowledge (TPACK), which strains the necessity of balancing technology, pedagogy, and content knowledge in teaching (Schmidt et al., 2009). Furthermore, the study affirms the relevance of Self-Determination Theory (SDT), demonstrating that intrinsic motivation is strengthened when teachers experience autonomy, social support, and professional recognition (Deci & Ryan, 1985 ; Urhahne et al.,2023; Nasir et al,2024).

In addition, the findings are consistent with prior research indicating that organisational support and professional development significantly influence teachers' readiness and ability to implement technology-based teaching (Teo, 2014; Granić & Marangunić, 2022). The study also reinforces the argument by Creswell (2016) and Yin (2018) that hands-on training and collaborative learning approaches are more effective than purely theoretical training in developing practical competency among teachers. Practically, this study offers important implications for stakeholders, particularly the Ministry of Education Malaysia and curriculum developers. Strengthening teacher professional development through continuous, practice-based training, establishing sustainable Professional Learning Communities (PLC), and ensuring systematic management of RBT facilities are essential steps towards enhancing the implementation of technology-integrated teaching.

In conclusion, the integration of technology in RBT teaching is not solely dependent on an individual teacher's capability. Rather, it is largely determined by the extent to which school systems provide a supportive, coherent, and sustained learning environment. Visionary leadership, structured professional development, and strong intrinsic motivation collectively serve as the foundation for achieving meaningful and sustainable digital education in the 21st century (Fullan, 2020; Tondeur et al., 2018; Yunus & Hussein, 2022).

ACKNOWLEDGEMENT

The authors would like to express their sincere appreciation to the participating RBT teachers and school administrators for their cooperation and support during the data collection process. The authors also acknowledge the relevant educational authorities for granting permission to conduct this study.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Data Availability Statement

The data that support the findings of this study are not publicly available due to confidentiality and ethical considerations involving teacher participants.

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