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Rethinking mathematics learning resources: An interpretative phenomenological study of Indonesian mathematics teachers in digital learning contexts

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Abstract

The rapid expansion of digital technology requires mathematics teachers to integrate diverse learning resources effectively; however, existing studies have largely emphasized resource mapping rather than teachers lived experiences and meaning-making. This study addresses this gap by offering a phenomenological perspective on how teachers interpret learning resources in digital contexts. Using a qualitative interpretive paradigm and Interpretative Phenomenological Analysis (IPA), the study explores Indonesian mathematics teachers' perceptions of resource utilization. Seventy-five teachers from ten cities participated, a sample size methodologically appropriate for IPA. Data were collected through semi-structured open-ended questionnaires and analyzed using IPA procedures. Findings indicate that although teachers increasingly access internet-based resources, textbooks remain the primary instructional reference due to their perceived curricular coherence. Worksheets are considered the most effective resource because they promote structured reasoning, contextual problem-solving, and explicit cognitive engagement, thereby supporting deeper conceptual understanding. These findings align with broader debates in Digital Pedagogy that emphasize pedagogical coherence over technology-driven instruction. Despite ample resources, utilization is constrained by limited digital pedagogical competence and recurring technical challenges. This study contributes by foregrounding teachers' meaning-making and informing professional development and resource design.

Keywords: digital literacy; learning resources; mathematics education; mathematics teachers; phenomenological analysis

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Introduction

Learning resources play a fundamental role in connecting the abstract representations of mathematics with meaningful learning experiences for students, as they serve as tools, practices, and artifacts used by teachers to help students progressively build conceptual understanding(Pepin et al., 2013; Rezat et al., 2021). The quality of interaction between teachers and learning resources is not only determined by the material characteristics of the resources themselves, but also by how teachers interpret, select, and adapt them to the pedagogical needs of the classroom (Pepin et al., 2013; Rezat et al., 2021). Thus, learning resources function as pedagogical bridges that structure the ways students concretely understand mathematical ideas (Potari, 2023).

The development of digital technology has expanded the spectrum of learning resources available to teachers, including interactive videos, learning applications, e-learning platforms, and mathematical simulations (Haleem et al., 2022). This transformation drives a paradigm shift toward more dynamic, multimodal, and student-centered learning environments (Fernando, 2021). Teachers are required to develop technological literacy and digital pedagogical skills in order to meaningfully integrate these learning resources (Haleem et al., 2022). Empirical studies from Europe and North America indicate that access to digital resources alone does not guarantee meaningful integration; rather, teachers' pedagogical beliefs and instructional goals play a decisive role (Bice & Tang, 2022; Ertmer, 2005). However, this change does not always progress linearly, especially in developing countries where the availability of infrastructure, digital competence, and teaching culture varies significantly (Fatimah et al., 2021; Mursalin et al., 2024). Similar patterns of uneven technology integration have also been reported in other developing educational contexts, indicating that this challenge extends beyond national boundaries.

In the Indonesian context, the imbalance between the availability of learning resources and their use in instructional practice remains a major challenge (Wahyuningsih et al., 2021). Although many schools have relatively adequate learning resources, mathematics instruction is still dominated by traditional approaches such as the use of textbooks or lecture-based methods with routine exercises (Fatimah et al., 2021). Preliminary observations at one school indicate that teachers continue to teach conventionally despite the availability of digital facilities (Research team observation). Rather than the absence of resources, previous studies suggest that limitations in digital pedagogical competence, unstable connectivity, and restricted access to functional devices play a more decisive role in shaping teachers' instructional choices (Heena & Nidhi, 2022).

Professional support for teachers in the form of training and the provision of relevant learning resources is essential to improving the quality of mathematics instruction (Mohamed et al., 2023). Guided by insights from Vygotsky's sociocultural theory, this study adopts an interpretive lens that foregrounds how teachers' experiences with learning resources are shaped through social interaction and contextual practice (Rahmatirad, 2020). Thus, the utilization of learning resources is not merely a technical matter, but an interpretive process influenced by values, experience, and the social context of education (Panya & Nyarwath, 2022). This

interpretation determines how learning resources are used to create engaging, relevant, and contextual learning experiences (Morales Jr et al., 2024).

Previous studies have made important contributions but still leave gaps that need to be addressed. The study by Gracin and Trupčević shows that teachers use learning resources based on time efficiency, but it does not examine how teachers evaluate the effectiveness of those resources in a digital context (Gracin & Trupčević, 2022). Research by Julie and Maat as well as Mithans and Ivanuš Grmek emphasizes that textbooks remain the primary reference due to their stability, but these studies are descriptive in nature and have not compared teachers' perceptions of textbooks with digital resources (Julie & Maat, 2021; Mithans & Ivanuš Grmek, 2020).

Research on digital technology has also demonstrated its great potential to transform mathematics learning through multimodality and wider access to information (Engelbrecht et al., 2020; Haleem et al., 2022). However, these studies do not illustrate how teachers deal with technical limitations and digital competence in everyday practice (Muhazir & Retnawati, 2020). The study by Wahyuningsih et al. (2021) successfully identified teachers' barriers, but it has not yet explained how these barriers influence teachers' interpretation of learning resources (Wahyuningsih et al., 2021).

On the other hand, research on worksheets has shown their effectiveness in improving conceptual understanding and problem-solving skills (Dallyono et al., 2025; Sutarni et al., 2024). However, these studies have not yet explained how teachers position worksheets within a broader ecosystem of learning resources or the psycho-pedagogical reasons behind their preference for worksheets over digital media (Harini et al., 2023; Tumangger et al., 2024). Comparable findings from international contexts suggest that teachers often value worksheets for their epistemic affordances, such as scaffolding reasoning and making thinking visible, rather than for technological novelty (Fan et al., 2013). Although global reports such as UNESCO (2023) emphasize the importance of digital learning resources, they also acknowledge that contextual factors in developing countries significantly influence how such resources are interpreted and used in practice.

In addition to these theoretical gaps, there are also methodological gaps. Most previous studies have employed quantitative surveys or product development research, which do not capture the complexity of teachers' subjective experiences in selecting and using learning resources (Smith et al., 2009). Interpretative phenomenological approaches are rarely used in studies on mathematics learning resources, leaving a wide opportunity to understand teachers' experiences more deeply (Gill, 2020; Rajasinghe & Garvey, 2023). Based on these gaps, this study aims to explore in depth the experiences of Indonesian mathematics teachers in utilizing learning resources in the digital era. Specifically, the study identifies the types of learning resources perceived as most effective, examines teachers' perceptions of their impact on student learning outcomes, explores the challenges they face, and maps the professional training needs required to optimize the use of learning resources (Striepe, 2021).

This study provides a theoretical contribution by enriching the literature through an interpretive perspective on the utilization of learning resources and offering phenomenological insight into teachers' meaning-making processes related to resource use (Pepin et al., 2017).

Practically, the findings of this research provide an empirical basis for the development of teacher training policies, digital curriculum design, and the provision of mathematics learning resources that are more responsive to teachers' needs across developing educational contexts, not only in Indonesia (UNESCO, 2023). By understanding the dynamics of teachers' meaning-making, this study has the potential to support the development of a more adaptive, inclusive, and sustainable mathematics learning ecosystem (Irish et al., 2023).

In order to achieve the research objectives, we established four research questions.

Q1. How do Indonesian mathematics teachers utilize and interpret different learning resources in their instructional practices in the digital era?

Q2. How do mathematics teachers perceive the influence of various learning resources on students' mathematical understanding and learning motivation?

Q3. What challenges do mathematics teachers experience in utilizing learning resources, particularly digital resources, in mathematics instruction?

Q4. What professional development needs do mathematics teachers identify as essential for improving the effective use of learning resources in mathematics teaching?

Methods

This study employs an interpretive paradigm grounded in Vygotsky's sociocultural theory, which views the construction of knowledge as shaped by social interaction, experience, and cultural context (Rahmatirad, 2020). This paradigm aligns with the aim of the study, which seeks to explore teachers' subjective interpretations of their experiences in utilizing mathematics learning resources in the digital era (Panya & Nyarwath, 2022). To achieve this aim, a hermeneutic phenomenological approach was chosen because it allows for an in-depth interpretation of participants lived experiences (Gill, 2020).

Research design

This study employs Interpretative Phenomenological Analysis (IPA) as the primary analytical framework. IPA is selected due to its focus on exploring the personal meanings constructed by individuals based on their lived experiences (Smith et al., 2009). This approach aligns with the aim of the study, which emphasizes teachers' subjective experiences in selecting, utilizing, and interpreting the effectiveness of mathematics learning resources (Rajasinghe & Garvey, 2023). Although Interpretative Phenomenological Analysis (IPA) is conventionally conducted with small and relatively homogeneous samples, the inclusion of a larger participant pool in this study was a deliberate methodological choice aimed at capturing experiential variation across diverse educational contexts rather than achieving statistical representativeness. To preserve the idiographic commitment of IPA, the analysis prioritized intensive, case-by-case interpretative engagement with individual participants' narratives. Only after this idiographic phase were patterns of convergence and divergence examined through a structured cross-case analysis, ensuring that shared themes emerged from interpretative depth rather than from aggregative or frequency-based procedures.

Participants and sampling technique

The demographic characteristics of the participants are presented in Figure 1.

Age (years)	*Number of Participants (≈)*	*Teaching Experience (years)*	*Number of Participants*
20–30	30	0–10	33
31–40	26	11–20	40
41–50	12	21–30	3
>50	7	>30	4

(a) Participants' age and teaching experience

(b) Participants' residence area

Figure 1. Demographic characteristics of the participants

The study involved 75 mathematics teachers from ten cities in Indonesia. Participants were selected using purposive sampling based on the following criteria: (1) actively teaching mathematics at junior high school, senior high school, or vocational school levels; (2) having a minimum of one year of teaching experience; and (3) willingness to provide in-depth information regarding the utilization of learning resources. Although the sample size is larger than is typical for IPA studies, this design choice was intentional to capture experiential variation across diverse educational contexts rather than to achieve statistical representativeness. Variation in age, teaching experience, and school level was intentionally considered to capture a broad range of teaching contexts and professional experiences, ensuring analytical richness rather than statistical representativeness (Selepe & Mphahlele, 2025).

To preserve the idiographic commitment of IPA, an initial in-depth analysis was conducted on a purposively selected subset of 18 cases that represented variation in teaching level, experience, and regional context. These cases were analyzed case-by-case before any cross-case synthesis was undertaken. Only after the idiographic patterns within these individual cases were fully developed did the analysis proceed to examine convergences and divergences across the remaining participants. This staged analytic strategy ensured that phenomenological depth was maintained despite the broader sample size.

Research instrument

The primary research instrument was a semi-structured open-ended questionnaire designed to gather teachers' narratives and experiences in utilizing learning resources. The questions were intentionally formulated to prompt reflection and meaning-making rather than short descriptive responses. Examples of guiding questions (translated into English) include: (1) *Which learning resources do you most frequently use in teaching mathematics, and why?*; *(2) How do these learning resources influence students' understanding of mathematical concepts?*; (3) *What challenges do you experience when using ditigal learning resources in*

your learning?, dan (4) *What types of professional support or training do you need to improve your use of learning resources?.* A full list of guiding questions is provided in the Appendix to enhance methodological transparency. This instrument was chosen because it allows participants to freely explain their experiences while remaining aligned with the goals of the study (Striepe, 2021). Although in-depth interviews are commonly used in IPA studies, open-ended questionnaires were employed in this study to accommodate participants' geographical dispersion while still eliciting reflective, experience-based responses. To ensure depth of meaning, questions were intentionally phrased to prompt reflection, interpretation, and personal evaluation rather than short descriptive answers.

Data collection procedure

Data collection was conducted using a digital questionnaire distributed through Google Forms to facilitate participant access from various regions and ensure consistency in response formats. The data were collected over a designated period and stored in digital form for subsequent analysis. The use of a semi-structured open-ended questionnaire enhanced the credibility of the data, as it allowed participants to narratively express their real experiences (Stenfors et al., 2020). Participants were encouraged to elaborate on their responses using examples from their teaching practice, which supported the generation of rich, text-based data suitable for phenomenological interpretation. A sample of the guiding questions is provided in the Appendix to enhance methodological transparency.

Data analysis technique

The data in this study were analyzed using the Interpretative Phenomenological Analysis (IPA) approach based on the guidelines of Smith, Flowers, and Larkin (2009), which emphasizes the exploration of subjective meanings derived from participants lived experiences. The analysis began with repeated readings of each participant's response to achieve immersion in the data. During this idiographic phase, initial noting was conducted at three interconnected levels: descriptive comments (content-focused), linguistic comments (use of language and emphasis), and conceptual comments (interpretive insights).

These initial notes were then transformed into emergent themes that captured essential aspects of each participant's experience. Subsequently, related emergent themes were clustered through processes of abstraction and subsumption to form superordinate themes within each individual case. This analytic sequence reflects the IPA progression from detailed idiographic engagement to higher-level interpretive structuring. After completing the within-case analysis, a structured cross-case analysis was conducted to identify patterns of convergence and divergence across participants, resulting in the final set of superordinate themes representing shared meaning-making while retaining sensitivity to individual variation.

To enhance analytical rigor, all data were coded using MAXQDA 2024 software, including code frequency analysis, code co-occurrence, summary grid, and code mapping, allowing relationships among themes to be visualized and systematically verified (Rajasinghe & Garvey, 2023). The software was used as an analytic aid rather than a substitute for

interpretive judgment, consistent with IPA principles. Figure 2 presents a conceptual overview of the IPA workflow, illustrating the analytical progression from hermeneutic phenomenology to Interpretative Phenomenological Analysis (IPA), with a focus on teachers' subjective experiences and their perceived domains of learning resources, including effectiveness, perceived influence, challenges, and professional needs. This figure is intended to provide a simplified representation of the analytical process rather than a comprehensive depiction of all procedural steps.

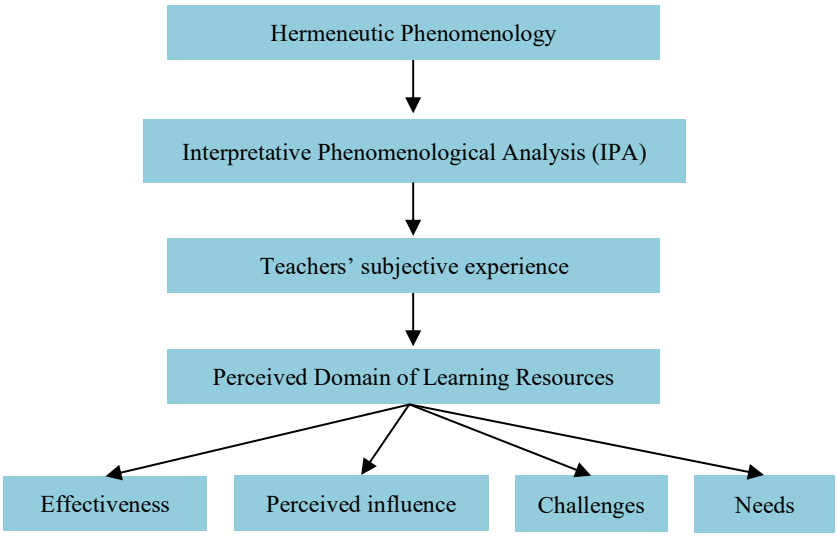


Figure 2. Conceptual model of teachers' meaning-making of learning resource utilization through IPA

Validity, credibility, and ethical considerations

Research validity was maintained through analytic triangulation, in which the results of manual coding were compared with MAXQDA analyses to ensure consistency in interpretation (Stenfors et al., 2020). The credibility of the data was strengthened by collecting teachers' real experiences through open-ended questions that minimized researcher bias (Striepe, 2021). This study adhered to ethical principles: (1) participant consent was obtained through informed consent; (2) identity confidentiality was protected by using anonymous codes; and (3) the data were used solely for academic purposes in accordance with qualitative research guidelines (Orb et al., 2001).

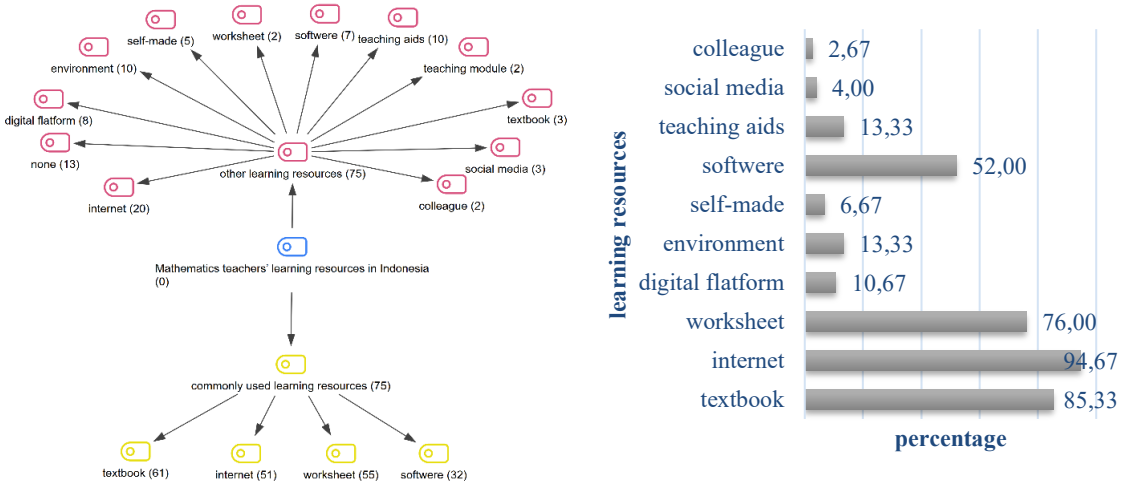
Results

The effectiveness of learning resource utilization by Indonesian mathematics teachers

Analysis of teachers' open-ended responses reveals a nuanced pattern of learning resource utilization that reflects both continuity and transition in instructional practice. Rather than indicating simple frequency of use, the findings point to how teachers *position* different

resources within their pedagogical reasoning. Although internet-based resources are frequently accessed, textbooks continue to function as the primary instructional reference, particularly for structuring content and aligning lessons with the national curriculum. This suggests that teachers are navigating a transitional phase in which digital resources are incorporated pragmatically while textbooks retain epistemic authority. From an interpretative perspective, textbooks are not merely used out of habit but are experienced as pedagogically stabilizing resources. One teacher noted: "*I still rely on textbooks because the material flow is clear and aligned with the curriculum, so I feel more confident when teaching*" (Teacher 12, translated from Indonesia language).

Figure 3(a) visually represents this pattern through differentiated node structures, with blue nodes indicating core categories of learning resources, yellow nodes representing commonly used general resources, and pink nodes denoting additional resources that emerged inductively from the data. Rather than depicting mere frequency, this visualization highlights the hierarchical positioning and perceived centrality of different learning resources within teachers' instructional practices.



(a) Mapping of learning resources (b) Percentage of learning resource usage

Figure 3. Patterns of learning resource utilization among Indonesian mathematics teachers

Figure 3 illustrates this hierarchy of resources by highlighting the perceived centrality of textbooks alongside emerging digital materials. The figure is intended to represent teachers' experiential prioritization of resources rather than their numerical dominance. While teachers demonstrate openness toward digital materials, deeper technological integration remains limited, indicating that digital resources are often used to supplement, rather than transform, existing instructional practices. Teachers' resource selection is consistently guided by pedagogical considerations, particularly the extent to which a resource supports students' conceptual understanding. This emphasis reflects teachers' experiential orientation toward cognitive clarity rather than technological novelty. This finding aligns with previous research highlighting the role of well-designed learning resources in strengthening students' mathematical conceptual understanding (Chimmalee & Anupan, 2022).

Overall, Figure 3(a) and Figure 3(b) reveal that while Indonesian mathematics teachers are increasingly incorporating digital learning resources, the depth of technological integration remains limited. This pattern highlights the need for targeted professional support aimed at strengthening teachers' digital pedagogical competence, so that technology integration can move beyond access and frequency toward more meaningful and sustainable instructional use.

The influence of learning resources on students' mathematical understanding

Teachers articulated relatively consistent interpretations of how learning resources influence students' mathematical understanding. Learning resources are perceived not only as instructional media, but as tools that shape students' ways of thinking, reasoning, and engaging with mathematical problems. This meaning-making process is captured visually in Figure 4, which maps perceived relationships among resources, pedagogical functions, and learning outcomes.

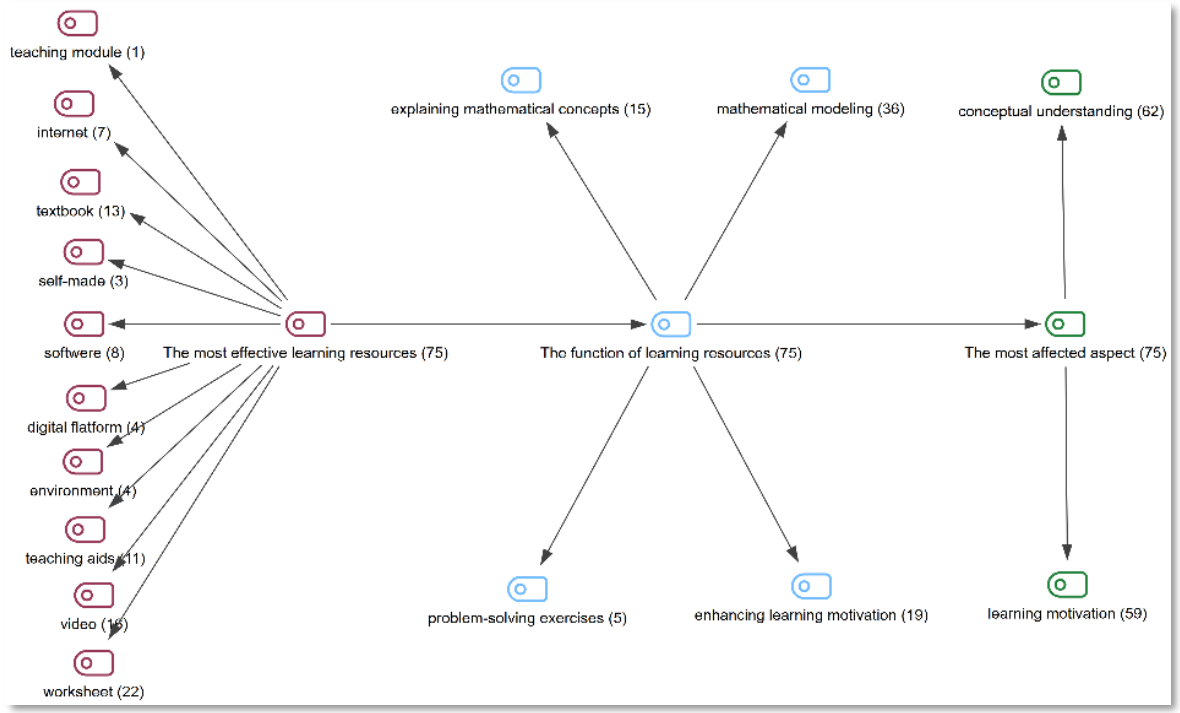


Figure 4. Teachers perceived relationships between learning resources, pedagogical functions, and students' mathematical understanding

Across participants' accounts, worksheets emerged as the learning resource perceived as most effective for fostering conceptual understanding. Teachers interpreted worksheets as epistemic tools that externalize students' thinking processes and make reasoning visible. One teacher reflected: *"Worksheets help students think step by step, so I can see where their understanding breaks down"* (Teacher 41, translated from Indonesia language).

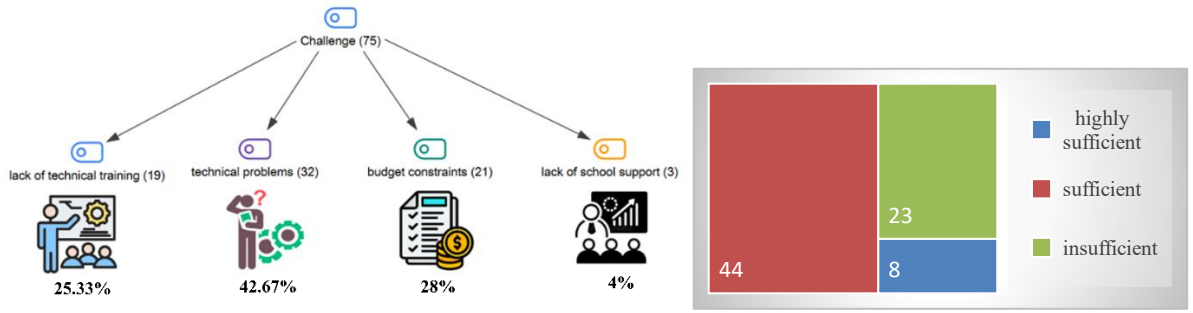
Furthermore, the results of the analysis show that the two aspects of learning outcomes most influenced by the use of learning resources are conceptual understanding and learning motivation. Teachers believe that appropriate learning resources encourage students to develop

a deeper understanding of concepts rather than merely memorizing procedures. At the same time, engaging and contextual learning resources can enhance students' motivation to participate actively in the learning process. Overall, these findings indicate that the appropriate selection and utilization of learning resources play a crucial role in strengthening students' mathematical understanding while also fostering their motivation to learn.

Challenges faced by mathematics teachers in utilizing learning resources

Teachers' narratives reveal that challenges in utilizing learning resources are experienced less as issues of availability and more as constraints on pedagogical agency. Technical difficulties, limited digital skills, and insufficient training were interpreted as factors that undermine teachers' sense of instructional control. As one participant stated: *"The facilities are there, but I don't always know how to use them effectively, so I return to what I'm comfortable with"* (Teacher 8, translated from Indonesia language).

Figure 5 visualizes these challenges thematically, emphasizing the dominance of technical and competence-related constraints. Rather than focusing on proportional differences, the figure highlights how recurring technical issues shape teachers' instructional decisions. Teachers often respond to such constraints by reverting to familiar resources such as textbooks and worksheets, which they perceive as reliable and manageable within classroom realities.



(a) Challenges faced by teachers in mathematics learning

(b) Learning resources availability

Figure 5. Distribution of challenges faced by mathematics teachers in utilizing learning resources

Importantly, teachers generally perceive learning resources in their schools as adequate, indicating a gap between access and effective utilization. This gap underscores that the central challenge lies in teachers' capacity to integrate resources meaningfully, rather than in resource scarcity itself.

Mathematics teachers' needs for improving instructional quality

Teachers articulated clear professional needs related to improving instructional quality through learning resource utilization. These needs extend beyond access to facilities and emphasize the development of pedagogical competence and creative capacity. Teachers framed training not

merely as technical upskilling, but as a means to enhance their professional agency as instructional designers.

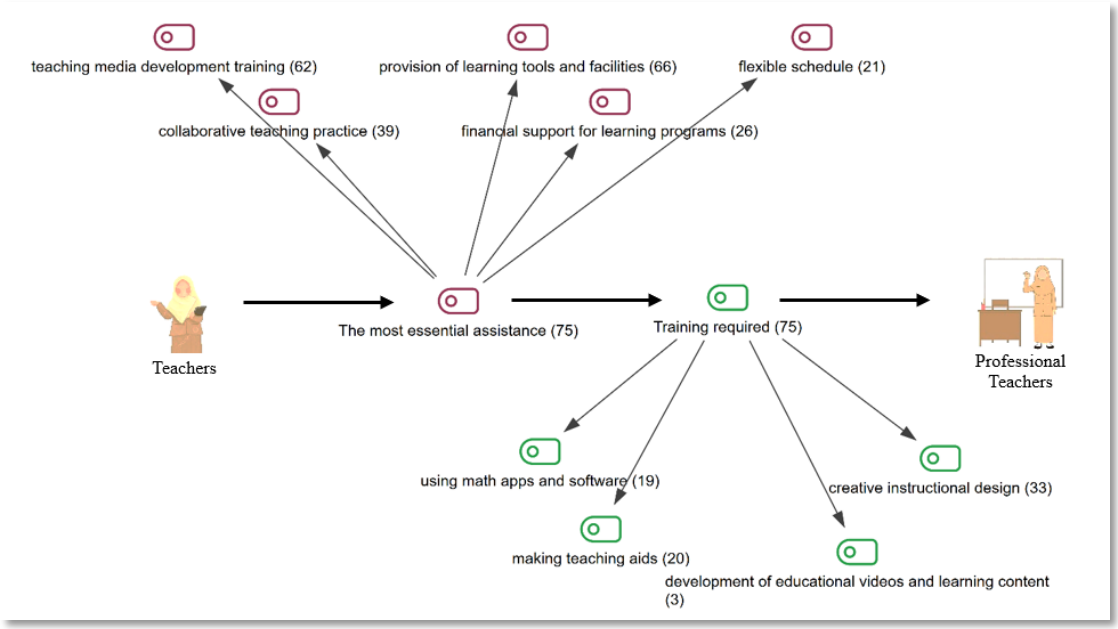


Figure 6. Teachers prioritized professional needs for improving instructional quality

The results presented in Figure 6 indicate that the most important forms of support, according to teachers, are the provision of adequate learning facilities and training for developing instructional media (62 responses). Teachers emphasize that the availability of sufficient technological equipment is a crucial foundation for effectively implementing instructional innovations. In addition, the types of training most needed include creative instructional design, the use of mathematical applications and software, the creation of teaching aids, and the development of educational videos and learning content. This indicates that teachers require support that is not only technical but also creative, enabling them to produce learning resources that are engaging, relevant, and aligned with the needs of mathematics instruction in the digital era.

Overall, these findings indicate that the improvement of teacher professionalism is strongly influenced by the availability of supporting facilities and technology-oriented training focused on innovation. Such support enables teachers not only to master digital tools, but also to use them to design more meaningful learning experiences for students. The relationship between teachers' needs, the utilization of learning resources, and their impact on students' understanding and motivation is visualized in Figure 7, which illustrates the conceptual connections among the key components of the findings in this study.

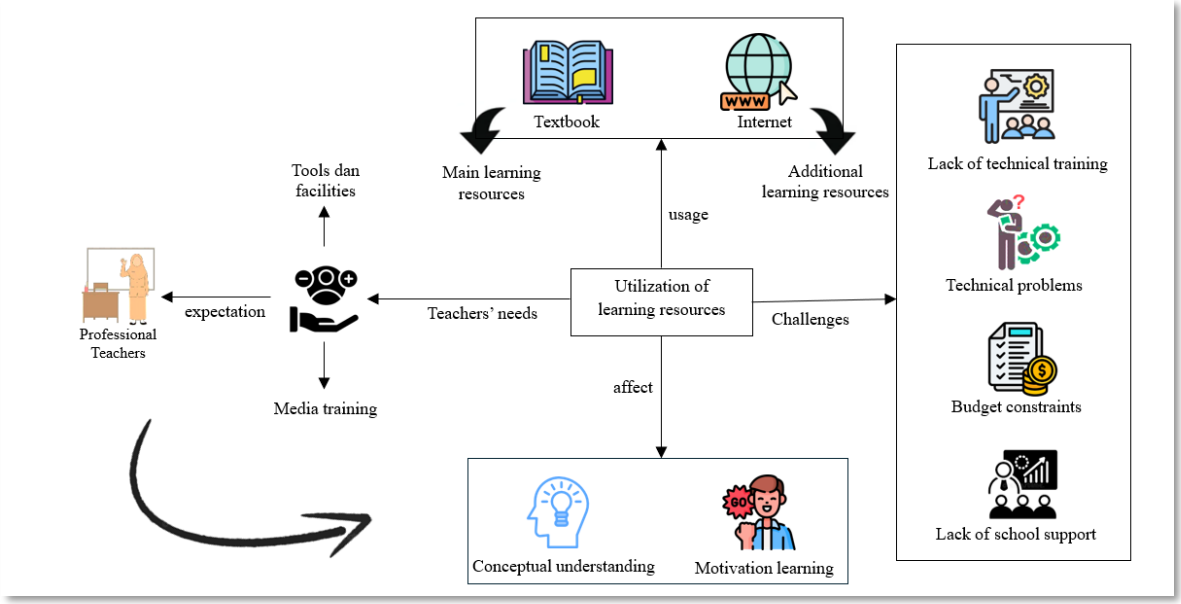


Figure 7. Conceptual integration of teachers' needs, learning resource utilization, and perceived instructional outcomes

Discussion

The effectiveness of learning resource utilization by Indonesian mathematics teachers

Drawing on Interpretative Phenomenological Analysis, this study foregrounds how Indonesian mathematics teachers make sense of learning resources within their instructional realities. The finding that textbooks remain the primary instructional reference reflects not merely habitual use, but teachers' cognitive reliance on resources perceived as epistemically stable, curriculum-aligned, and professionally legitimized, shaping their sense of instructional control. This result is consistent with previous studies stating that textbooks remain the primary learning resources used by teachers in classroom instruction (Julie & Maat, 2021; Tang et al., 2025). Other findings also indicate that textbooks still represent the essential didactic tool in teaching school subjects and school educators mostly use them in the stage of teaching the educational content (Mithans & Ivanuš Grmek, 2020; Nurhikmayati et al., 2025). The use of textbooks as the central reference in teaching and learning is one strategy teachers adopt to achieve learning objectives more effectively (Gracin & Trupčević, 2022; Mithans & Ivanuš Grmek, 2020). Textbooks play an important role as primary guidance for teachers in supporting students' understanding of mathematical concepts (Feng & Liu, 2025; Glasnovic Gracin, 2018). Several studies indicate that textbooks are used to a great extent by students as a source of tasks, particularly practice exercises (Pepin & Haggarty, 2001).

Along with the rapid development of technology, teachers have begun to adapt by utilizing the internet as the most frequently used additional learning resource (see Figure 3). From a phenomenological perspective, this shift reflects teachers' sense-making processes as they cautiously integrate digital resources without disrupting established instructional

coherence. Through access to big data, teachers can obtain various references, ideas, and supporting media that help bridge students' difficulties in understanding mathematical content (Baig et al., 2020). However, this shift appears largely additive rather than transformative, as the combination of textbooks and the internet functions mainly to supplement existing instructional practices rather than to redesign them. Nevertheless, this combination has become an effective strategy for teachers to enhance the quality of mathematics instruction in the classroom. Furthermore, other studies have identified that the internet is used not only as a tool and a learning resource, but also as principles of design of new settings and social interaction (Engelbrecht et al., 2020).

The shift in the function of the internet from merely a learning resource to becoming a principle in designing learning environments and a medium for social interaction can bring a transformative impact on the educational ecosystem. Classroom learning becomes more interactive, flexible, and student-centered through the use of digital platforms that enable collaboration and independent exploration (Kerimbayev et al., 2023; Pandey et al., 2025). Teachers take on the role of learning designers and digital facilitators who are required to possess technology-based pedagogical competence (Mariscal et al., 2023). Teachers' accounts in this study reveal that this shift is experienced less as a smooth progression and more as a negotiated process shaped by contextual constraints. Similar gaps between policy expectations and classroom enactment have been documented in developing and middle-income countries, where uneven pedagogical support and infrastructure limit transformative technology use.

Contrary to the transformative potential often associated with digital learning, this study shows that only a small proportion of Indonesian mathematics teachers possess technology-based pedagogical competencies. Teachers' limited engagement with educational software, digital platforms, and interactive media aligns with previous findings indicating constrained technology implementation in mathematics instruction (Muhazir & Retnawati, 2020; Wahyuningsih et al., 2021). Importantly, teachers interpret this limitation not primarily as a lack of access, but as a challenge to professional self-efficacy and instructional identity as content-oriented educators. This experiential interpretation constrains deeper technological integration, even when resources are available.

The influence of learning resources on students' mathematical understanding

This study reveals an interesting phenomenon: on one hand, textbooks remain the primary learning resource used by teachers in instructional practices; yet, on the other hand, teachers perceive students' worksheets as the most effective resource for enhancing students' mathematical understanding. Teachers believe that worksheets play a more relevant role because they provide structured, contextual, and scaffolded exercises that help students develop deep conceptual understanding and foster higher-order mathematical thinking skills (Dallyono et al., 2025; Sutarni et al., 2024). From teachers' lived experiences, worksheets function as tools that make students' reasoning visible and traceable, enabling closer pedagogical monitoring. This interpretation aligns with studies highlighting the role of problem-solving-oriented worksheets in strengthening cognitive engagement and mathematical representation (Harini et

al., 2023; Tumangger et al., 2024). Moreover, teachers also position textbooks, teaching aids, and videos as complementary learning resources that support the role of worksheets within the mathematics learning process.

The phenomenon that teachers still view students' worksheets as the most effective learning resource for improving mathematical understanding, despite the rapid advancement of digital technology, reflects a pedagogical orientation that emphasizes direct cognitive engagement and reflective learning. Teachers believe that worksheets provide a more structured, contextualized, and thinking-process-oriented learning environment (Dallyono et al., 2025; Sutarni et al., 2024), compared to the use of digital media, which often highlights visual or interactive features without deeper conceptual development (Engelbrecht & Borba, 2024). In this sense, worksheets function not merely as instructional materials, but as epistemic tools that support the articulation, monitoring, and reflection of mathematical thinking. From their perspective, worksheets allow students to write, calculate, and explicitly reflect on the steps of problem solving—processes essential in building conceptual understanding and procedural fluency (Harini et al., 2023; Tumangger et al., 2024).

Although the internet offers various mathematical problem-solving resources through artificial intelligence, as well as learning technologies such as applications and digital platforms that provide efficiency and wide access, teachers still perceive that these resources cannot fully replace the reflective and cognitive interaction supported by the direct use of worksheets in the classroom (Blyznyuk & Kachak, 2024). This suggests that teachers evaluate learning resources based on their epistemic affordances rather than their technological sophistication. The findings of this study are also consistent with other research stating that although current technologies, such as AI, hold great potential to enhance education, long-term implications related to resources, curriculum alignment, and ethical considerations must be taken into account (Filiz et al., 2025). Therefore, teachers' preference for worksheets illustrates that the effectiveness of learning resources is not solely determined by their technological sophistication, but by their ability to stimulate deep mathematical thinking activities aligned with students' characteristics and learning objectives.

Challenges faced by mathematics teachers in utilizing learning resources

Rather than treating technical barriers, digital skills, and infrastructure limitations as separate issues, this study synthesizes them as a single experiential challenge related to teachers' professional readiness and pedagogical agency. Although learning resources are generally available, teachers experience limited digital competence, unstable connectivity, and inadequate devices as factors that undermine instructional control. From an IPA lens, these recurring challenges shape teachers' sense-making, prompting reliance on familiar and trusted resources. These findings align with research emphasizing that technology integration depends heavily on teachers' competence, confidence, and pedagogical comfort (Demissie et al., 2022; Tondeur et al., 2019; Wahyuningsih et al., 2021), as well as institutional support structures (UNESCO, 2023).

These challenges have important implications for the quality of mathematics instruction. Limited training and insufficient technical support not only obstruct the use of digital learning resources but also reinforce teachers' reliance on conventional materials such as textbooks and worksheets. This reliance can be interpreted as a risk-avoidance strategy grounded in professional self-efficacy rather than resistance to innovation. This dependency has the potential to widen the digital divide between schools with strong technological readiness and those without, thereby hindering equitable improvement in the quality of mathematics learning (van de Werfhorst et al., 2022). Moreover, recurring technical difficulties may reduce teachers' motivation and self-efficacy in attempting new instructional strategies, ultimately constraining pedagogical innovation and the sustainable adoption of technology (Li et al., 2025). Research related to technology integration also indicates that teachers' self-efficacy, digital readiness, and perceived control over technology are key factors in determining whether they will adopt digital media or continue using conventional methods (Sharma & Saini, 2022).

Therefore, efforts to improve the quality of learning through the utilization of digital learning resources require a more comprehensive approach. This approach cannot solely focus on providing devices or technology access, but must also include strengthening teachers' capacity as the primary implementers of instruction. Relevant training, institutional support, and adequate infrastructure are key components to ensure that technology can be used effectively in mathematics education (Timotheou et al., 2023). Without addressing teachers' pedagogical confidence and professional agency, technology adoption is likely to remain surface-level, failing to provide a significant impact on students' mathematical understanding. This is consistent with findings indicating that technology integration that is not accompanied by pedagogical and institutional support often results in only basic-level use of technology and does not contribute to meaningful learning (Abedi, 2024).

Mathematics teachers' needs for improving instructional quality

Teachers expressed needs for facilities and training reflect aspirations to strengthen pedagogical agency rather than merely acquire operational skills. Training in instructional design, digital media development, and creative integration of technology is perceived as essential for improving instructional quality. These needs are consistent with research emphasizing continuous professional development as a cornerstone of teacher professionalism in digital contexts (Gluzman et al., 2018).

The findings illustrate that instructional effectiveness is shaped by the interaction between teachers' pedagogical decisions, professional orientations, and contextual constraints, rather than by access to resources alone. This pattern mirrors cross-national evidence showing that teacher competence, attitudes, and policy support are critical for meaningful digital integration (Akram et al., 2022). In addition, the UNESCO report emphasizes the importance of sustainable education policies, adequate funding, and professional training for teachers to close the infrastructure gap and improve schools' readiness for the digital transformation of education (UNESCO, 2023). Thus, although situated in Indonesia, the study's implications resonate strongly with challenges faced across developing and middle-income education systems.

The main contribution of this study lies in its phenomenological approach, which provides an in-depth understanding of how teachers interpret their experiences in using learning resources. This study not only maps the forms of learning resource use but also reveals the psychopedagogical reasons why certain resources—such as worksheets—are still considered most effective despite the digital learning context. By linking teachers' experiential interpretations with their pedagogical choices and professional needs, this study extends existing literature beyond descriptive accounts of resource use. This research also identifies an explicit relationship between technical challenges, pedagogical preferences, and teacher training needs, an integration of findings that has not been widely explained in previous studies. This insight provides an important theoretical contribution to the development of a more contextual model for the use of learning resources in the digital age.

Conclusion

Technological developments require mathematics teachers to adapt in order to utilize learning resources effectively. This study shows that most mathematics teachers in Indonesia continue to rely on textbooks as their primary instructional reference, while the use of the internet as a supplementary resource is increasing. An important finding is that teachers perceive student worksheets as the most effective learning resource for enhancing students' mathematical understanding, as worksheets provide structured, contextual, and gradual tasks that support conceptual development and make students' reasoning processes explicit.

Beyond practical implications, this study offers a theoretical contribution by demonstrating that the effectiveness of learning resources is shaped not only by their availability or technological sophistication, but by how teachers interpret their pedagogical affordances. Through Interpretative Phenomenological Analysis (IPA), this research reveals that learning resources function as epistemic and pedagogical mediators constructed through teachers lived experiences, professional identity, and sense-making processes. The use of IPA thus advances understanding of learning resource utilization from a tool-based perspective toward an interpretive, experience-based model.

Although learning resources are generally available, their effective use remains constrained by technical barriers and limited digital pedagogical competence. These findings indicate that improving learning quality requires strengthening teachers' professional capacity through sustained training and institutional support. Future research could extend this study by employing interview-based or mixed-method IPA designs, conducting cross-cultural or comparative phenomenological studies, or adopting longitudinal approaches to examine how teachers' meaning-making and learning resource utilization evolve across different educational contexts.

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Declarations

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References

Abedi, E. A. (2024). Tensions between technology integration practices of teachers and ICT in education policy expectations: implications for change in teacher knowledge, beliefs and teaching practices. *Journal of Computers in Education*, *11*(4), 1215–1234. https://doi.org/10.1007/s40692-023-00296-6

Akram, H., Abdelrady, A. H., Al-Adwan, A. S., & Ramzan, M. (2022). Teachers' perceptions of technology integration in teaching-learning practices: A systematic review. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.920317

Baig, M. I., Shuib, L., & Yadegaridehkordi, E. (2020). Big data in education: a state of the art, limitations, and future research directions. *International Journal of Educational Technology in Higher Education*, *17*(1), 44. https://doi.org/10.1186/s41239-020-00223-0

Blyznyuk, T., & Kachak, T. (2024). Benefits of interactive learning for students' critical thinking skills improvement. *Journal of Vasyl Stefanyk Precarpathian National University*, *11*(1), 94–102. https://doi.org/10.15330/jpnu.11.1.94-102

Chimmalee, B., & Anupan, A. (2022). Enhancement of mathematical conceptual understanding in a cloud learning environment for undergraduate students. *International Journal of Engineering Pedagogy (IJEP)*, *12*(6), 50–69. https://doi.org/10.3991/ijep.v12i6.33775

Dallyono, R., Hidayat, W., Kurniasari, Y., & Fitriani, N. (2025). The development of student worksheet to enhance students' mathematical understanding on two variable linear equation system topic. *(JIML) Journal of Innovative Mathematics Learning*, *8*(2), 313–334. https://doi.org/10.22460/jiml.v8i2.26877

Demissie, E. B., Labiso, T. O., & Thuo, M. W. (2022). Teachers' digital competencies and technology integration in education: Insights from secondary schools in Wolaita Zone,

Ethiopia. *Social Sciences & Humanities Open*, *6*(1), 100355. https://doi.org/10.1016/j.ssaho.2022.100355

Engelbrecht, J., & Borba, M. C. (2024). Recent developments in using digital technology in mathematics education. *ZDM – Mathematics Education*, *56*(2), 281–292. https://doi.org/10.1007/s11858-023-01530-2

Engelbrecht, J., Llinares, S., & Borba, M. C. (2020). Transformation of the mathematics classroom with the internet. *ZDM*, *52*(5), 825–841. https://doi.org/10.1007/s11858-020-01176-4

Fatimah, C., Asmara, P. M., Mauliya, I., & Puspaningtyas, N. D. (2021). Peningkatan minat belajar siswa melalui pendekatan matematika realistik pada pembelajaran berbasis daring [Enhancing students' learning interest through a realistic mathematics approach in online learning]. *MATHEMA JOURNAL*, *3*(2), 117–126. https://doi.org/https://doi.org/10.33365/jm.v3i2.1310

Feng, P., & Liu, J. (2025). A study on the primary school mathematics teachers' attention regarding the adoption of NCM textbooks. In *Recent Advances in Mathematics Textbook Research and Development* (Qi, et al, pp. 50–56). Springer Nature Singapore. https://doi.org/10.1007/978-981-97-8426-4_8

Fernando, J. (2021). Compliance of higher education institutions to outcome-based education for the 21st century learners. *International Multidisciplinary Research Journal*, *3*(2), 226–236. https://doi.org/10.54476/iimrj304

Filiz, O., Kaya, M. H., & Adiguzel, T. (2025). Teachers and AI: Understanding the factors influencing AI integration in K-12 education. *Education and Information Technologies*, *30*(13), 17931–17967. https://doi.org/10.1007/s10639-025-13463-2

Gill, M. J. (2020). Phenomenology as qualitative methodology. In *Qualitative Analysis: Eight approaches* (M Meyer & Järvine, pp. 73–94). Sage.

Glasnovic Gracin, D. (2018). Requirements in mathematics textbooks: A five-dimensional analysis of textbook exercises and examples. *International Journal of Mathematical Education in Science and Technology*, *49*(7), 1003–1024. https://doi.org/10.1080/0020739X.2018.1431849

Gluzman, N. A., Sibgatullina, T. V., Galushkin, A. A., & Sharonov, I. A. (2018). Forming the basics of future mathematics teachers' professionalism by means of multimedia technologies. *EURASIA Journal of Mathematics, Science and Technology Education*, *14*(5). https://doi.org/10.29333/ejmste/85034

Gracin, D. G., & Trupčević, G. (2022). Time as a resource in mathematics education: Teachers' perspectives. *Asian Journal for Mathematics Education*, *1*(2), 162–186. https://doi.org/10.1177/27527263221109034

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable Operations and Computers*, *3*, 275–285. https://doi.org/10.1016/j.susoc.2022.05.004

Harini, E., Islamia, A. N., Kusumaningrum, B., & Kuncoro, K. S. (2023). Effectiveness of E-Worksheets on problem-solving skills: A study of students' self-directed learning in the topic of ratios. *International Journal of Mathematics and Mathematics Education*, 150–162. https://doi.org/10.56855/ijmme.v1i02.333

Heena, C., & Nidhi, B. (2022). Barriers affecting the effectiveness of digital literacy training programs (DLTPs) for marginalised populations: A systematic literature review. *Journal of Technical Education and Training*, *14*(1). https://doi.org/10.30880/jtet.2022.14.01.010

Irish, C. K., Wells, M. S., Davis, J. S., Peck, K., & Clayton, C. (2023). Pandemic innovations in teacher education: Communities of practice, mentoring, and technology. *Education Sciences*, *13*(7), 653. https://doi.org/10.3390/educsci13070653

Julie, L. J. H., & Maat, S. M. (2021). The utilisation of textbook in teaching and learning mathematics among primary school mathematics teachers. *International Journal of Academic Research in Progressive Education and Development*, *10*(2). https://doi.org/10.6007/ijarped/v10-i2/10174

Kerimbayev, N., Umirzakova, Z., Shadiev, R., & Jotsov, V. (2023). A student-centered approach using modern technologies in distance learning: A systematic review of the literature. *Smart Learning Environments*, *10*(1), 61. https://doi.org/10.1186/s40561-023-00280-8

Li, X., Pei, X., & Zhao, J. (2025). Intrinsic motivation and self-efficacy as pathways to innovative teaching: a mixed-methods study of faculty in Chinese higher education. *BMC Psychology*, *13*(1), 859. https://doi.org/10.1186/s40359-025-03177-y

Mariscal, L. L., Albarracin, M. R., Mobo, F. D., & Cutillas, A. L. (2023). Pedagogical competence towards technology-driven instruction on basic education. *International Journal of Multidisciplinary: Applied Business and Education Research*, *4*(5), 1567–1580. https://doi.org/10.11594/ijmaber.04.05.18

Mithans, M., & Ivanuš Grmek, M. (2020). The use of textbooks in the teaching-learning process. In *New Horizons in Subject-Specific Education: Research Aspects of Subject-Specific Didactics* (pp. 201–228). University of Maribor Press. https://doi.org/10.18690/978-961-286-358-6.10

Mohamed, R. H., Khalil, I. A., & Awaji, B. M. (2023). Mathematics teachers' awareness of effective teaching practices: A comparative study. *Eurasia Journal of Mathematics, Science and Technology Education*, *19*(2), em2230. https://doi.org/10.29333/ejmste/12962

Morales Jr, H., Chval, K. B., DiNapoli, J., & Pizzi, T. G. (2024). Meaning-making systems: A multimodal analysis of a Latinx student's mathematical learning. *International Electronic Journal of Mathematics Education*, *19*(2), em0773. https://doi.org/10.29333/iejme/14363

Muhazir, A., & Retnawati, H. (2020). The teachers' obstacles in implementing technology in mathematics learning classes in the digital era. *Journal of Physics: Conference Series*, *1511*(1), 012022. https://doi.org/10.1088/1742-6596/1511/1/012022

Mursalin, M., Fonna, M., Elisyah, N., Ali, M., & Armita, D. (2024). Pelatihan penerapan gamifikasi dalam pembelajaran matematika untuk mahasiswa calon guru SMK [Training on the implementation of gamification in mathematics learning for prospective vocational school teachers]. *Jurnal Solusi Masyarakat Dikara*, *4*(1), 30–37. https://doi.org/https://doi.org/10.5281/zenodo.12344885

Nurhikmayati, I., Darhim, D., Dahlan, J. A., & Wijaya, T. T. (2025). A comparison of Indonesia and Singapore secondary school textbooks of mathematics: A praxeological analysis of cube and cuboid task design. *European Journal of Mathematics and Science Education*, *6*(1), 65–78. https://doi.org/10.12973/ejmse.6.1.65

Orb, A., Eisenhauer, L., & Wynaden, D. (2001). Ethics in qualitative research. *Journal of Nursing Scholarship*, *33*(1), 93–96. https://doi.org/10.1111/j.1547-5069.2001.00093.x

Pandey, M. K., Gupta, A. K., & Verma, R. K. (2025). *Implementing technology in student-centric learning environments: Prospects and challenges* (pp. 248–257). https://doi.org/10.1007/978-3-031-78949-6_27

Panya, K. O., & Nyarwath, O. (2022). Demystifying philosophies and paradigms underpinning scientific research. *The Strategic Journal of Business & Change Management*, *4*(9), 13671382. https://doi.org/https://doi.org/10.61426/sjbcm.v9i4.2498

Pepin, B., Choppin, J., Ruthven, K., & Sinclair, N. (2017). Digital curriculum resources in mathematics education: foundations for change. In *ZDM - Mathematics Education* (Vol. 49, Issue 5, pp. 645–661). Springer Verlag. https://doi.org/10.1007/s11858-017-0879-z

Pepin, B., Gueudet, G., & Trouche, L. (2013). Re-sourcing teachers' work and interactions: a collective perspective on resources, their use and transformation. *ZDM*, *45*(7), 929–943. https://doi.org/10.1007/s11858-013-0534-2

Pepin, B., & Haggarty, L. (2001). Mathematics textbooks and their use in English, French and German classrooms: *Zentralblatt Für Didaktik Der Mathematik*, *33*(5), 158–175. https://doi.org/10.1007/BF02656616

Potari, D. (2023). Tools and resources for mathematics teaching and mathematics teacher education. *Journal of Mathematics Teacher Education*, *26*(1), 125–127. https://doi.org/10.1007/s10857-023-09576-5

Rahmatirad, M. (2020). A Review of Socio-Cultural Theory. *SIASAT*, *5*(3), 23–31. https://doi.org/10.33258/siasat.v5i3.66

Rajasinghe, D., & Garvey, B. (2023). How experiencing executive coaching helps coaches feel they are independent learners and self-coaches: An interpretative phenomenological analysis. *International Journal of Evidence Based Coaching and Mentoring*, *21*(2), 162–178. https://doi.org/10.24384/ev3j-jn98

Rezat, S., Fan, L., & Pepin, B. (2021). Mathematics textbooks and curriculum resources as instruments for change. *ZDM - Mathematics Education*, *53*(6), 1189–1206. https://doi.org/10.1007/s11858-021-01309-3

Selepe, M. A., & Mphahlele, R. S. (2025). Integrating Africanised play into digital learning of mathematics in the foundation phase. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*. https://doi.org/10.23917/jramathedu.v10i2.6342

Sharma, S., & Saini, J. R. (2022). On the role of teachers' acceptance, continuance intention and self-efficacy in the use of digital technologies in teaching practices. *Journal of Further and Higher Education*, *46*(6), 721–736. https://doi.org/10.1080/0309877X.2021.1998395

Smith, J. A. ., Larkin, Michael., & Flowers, Paul. (2009). *Interpretative phenomenological analysis : Theory, Method and Research*. SAGE. https://www.researchgate.net/publication/221670349_Interpretative_Phenomenological_Analysis_Theory_Method_and_Research

Stenfors, T., Kajamaa, A., & Bennett, D. (2020). How to … assess the quality of qualitative research. *The Clinical Teacher*, *17*(6), 596–599. https://doi.org/10.1111/tct.13242

Striepe, M. (2021). Combining concept mapping with semi-structured interviews: adding another dimension to the research process. *International Journal of Research & Method in Education*, *44*(5), 519–532. https://doi.org/10.1080/1743727X.2020.1841746

Sutarni, S., Sutama, Prayitno, H. J., Sutopo, A., & Laksmiwati, P. A. (2024). The development of realistic mathematics education-based student worksheets to enhance higher-order thinking skills and mathematical ability. *Infinity Journal*, *13*(2), 285–300. https://doi.org/10.22460/infinity.v13i2.p285-300

Tang, M., Wijaya, T. T., Li, X., Cao, Y., & Yu, Q. (2025). Exploring the determinants of mathematics teachers' willingness to implement STEAM education using structural equation modeling. *Scientific Reports*, *15*(1). https://doi.org/10.1038/s41598-025-90772-z

Timotheou, S., Miliou, O., Dimitriadis, Y., Sobrino, S. V., Giannoutsou, N., Cachia, R., Monés, A. M., & Ioannou, A. (2023). Impacts of digital technologies on education and factors influencing schools' digital capacity and transformation: A literature review. *Education and Information Technologies*, *28*(6), 6695–6726. https://doi.org/10.1007/s10639-022-11431-8

Tondeur, J., Scherer, R., Baran, E., Siddiq, F., Valtonen, T., & Sointu, E. (2019). Teacher educators as gatekeepers: Preparing the next generation of teachers for technology

integration in education. *British Journal of Educational Technology*, *50*(3), 1189–1209. https://doi.org/10.1111/bjet.12748

Tumangger, W. R., Khalil, I. A., & Prahmana, R. C. I. (2024). The impact of realistic mathematics education-based student worksheet for improving students' mathematical problem-solving skills. *IndoMath: Indonesia Mathematics Education*, *7*(2), 196. https://doi.org/10.30738/indomath.v7i2.122

UNESCO. (2023). *Technology in education: A tool on whose terms? Global Education Monitoring Report 2023*.

van de Werfhorst, H. G., Kessenich, E., & Geven, S. (2022). The digital divide in online education: Inequality in digital readiness of students and schools. *Computers and Education Open*, *3*, 100100. https://doi.org/10.1016/j.caeo.2022.100100

Wahyuningsih, D., Wahyono, S. B., & Nugroho, A. A. (2021). Teachers' difficulties in developing learning resources. *The 2nd International on Meaningful Education (2nd ICMEd)*, 665–679. https://doi.org/10.18502/kss.v6i2.10024