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Teaching Mathematics Using Interactive Whiteboards: Do the Affordances Offset the Drawbacks?

Tsungai Dube[1] & Erica Dorethea Spangenberg*[2]

Although schools are provided with interactive whiteboards (IWBs) to digitize classrooms in the 21st century, they are often underutilized in mathematics classrooms. Therefore, this study established whether the affordances offset the drawbacks when Grade 10 teachers use IWBs to teach mathematics. This qualitative study involved 10 Grade 10 teachers purposively selected from five public township schools in an urban district in South Africa. Data were collected through semi-structured interviews and were thematically analyzed. The findings revealed that most teachers use IWBs to teach mathematics because they enable the presentation of visual graphics, collaboration, online teaching, increased learner participation, easy access to teaching resources, and interaction with software such as GeoGebra. Moreover, teachers perceived IWBs as enabling visualization, collaboration, learner participation, online teaching, and access to digital resources during mathematics instruction. However, some drawbacks to integrating IWBs for teaching included teachers' lack of technological and pedagogical knowledge, ineffective teacher training, technical issues, and load shedding. This study highlights the importance of using IWBs for teaching mathematics, provided the drawbacks are addressed. The findings may inform future continuous professional development programs on technology integration in mathematics teaching.

Keywords: Educational technology; instruction; interactive whiteboards; mathematics; secondary schools; mathematics teachers.

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[1] Department of Mathematics, Science and Technology Education, University of Johannesburg, Johannesburg, South Africa, ORCID number: 0000-0001-4244-3788, E-mail: shekinahhove@gmail.com
[2] Department of Mathematics, Science and Technology Education, University of Johannesburg, Johannesburg, South Africa, ORCID number: 0000-0003-3073-9239, E-mail: ericas@uj,ac.za

Introduction

Interactive whiteboards (IWBs) have become a prominent educational technology in contemporary classrooms, particularly for mathematics instruction, where they provide opportunities to enhance learner engagement, visualization, classroom interaction, and collaborative learning (De Vita et al., 2018b). As education systems increasingly embrace digital transformation, many countries have invested substantially in educational technologies to improve teaching quality and learner outcomes. In mathematics education, IWBs have the potential to support learner-centered and inquiry-based instructional approaches by enabling teachers and learners to interact dynamically with mathematical representations, digital resources, and specialized software.

The adoption of IWBs has expanded rapidly across many countries. In the late 1990s, schools in the United Kingdom began integrating IWBs into classroom instruction (Higgins et al., 2007). By 2007, approximately 750,000 IWBs had been installed worldwide (White, 2007). In Australia, the Strategic ICT Advisory Service project accelerated technology integration across schools, replacing many traditional classroom tools with IWBs. As part of the Australian Government's $2.2 billion Digital Education Revolution, approximately $40 million was allocated for teacher professional development in educational technologies (Northcote et al., 2010). Similarly, in South Africa, the Gauteng Department of Education announced a five-year R17 billion investment in 2014 to promote paperless classrooms by introducing IWBs (Business Tech, 2015). These investments reflect a broader policy commitment to transforming classroom pedagogy through digital technologies that promote learner engagement, collaboration, and higher-order thinking.

The integration of IWBs into mathematics classrooms offers several pedagogical affordances that extend beyond conventional teaching approaches. IWBs enable teachers to model mathematical processes while allowing learners to explore relationships between mathematical concepts through dynamic visualization (Gibson, 2015; Hadjerrouit, 2019). They also provide immediate feedback, facilitate interactive engagement, and support the use of mathematical software such as GeoGebra and Geometer's Sketchpad to enhance conceptual understanding and collaborative problem-solving (Abidin et al., 2018; Siregar, 2025; Warwick & Kershner, 2008). These capabilities create opportunities for learners to participate actively in mathematical investigations, manipulate multiple representations, and develop deeper conceptual understanding through exploration and discussion rather than passive observation.

Despite these affordances, the educational benefits of IWBs are not realized automatically. Research indicates that many teachers continue to use IWBs primarily as presentation devices or large electronic whiteboards rather than exploiting their interactive pedagogical capabilities. Furthermore, effective IWB integration often requires additional lesson preparation, technological competence, and classroom management skills, particularly in large classes (Dashtestani, 2019). Teachers also encounter technical challenges, including connectivity problems, software failures, hardware malfunctions, and equipment maintenance issues (Amiri & Sharifi, 2014). Although these challenges may hinder technology integration, they can be

mitigated through appropriate professional development, sustained technical support, and thoughtful pedagogical implementation (Karsenti, 2016).

Previous studies have reported positive outcomes associated with the integration of IWBs in mathematics education (De Vita et al., 2018a; Shi et al., 2021). Shi et al. (2021), in a systematic literature review, found that IWB-supported instruction positively contributes to learners' cognitive development, particularly when teachers adopt independent learning approaches. Likewise, De Vita et al. (2018b) found that Belgian mathematics teachers used IWBs to promote problem-solving activities using mathematical software, enabling both teachers and learners to move flexibly among multiple mathematical representations. These findings suggest that IWBs can support interactive, learner-centered mathematics instruction when effectively integrated into classroom practice.

However, despite growing international evidence on the educational value of IWBs, relatively little research has examined their use in South African mathematics classrooms, particularly in township schools, where contextual challenges may influence technology integration. Existing studies have focused primarily on the instructional benefits of IWBs. At the same time, comparatively less attention has been given to understanding how mathematics teachers simultaneously experience both the affordances and the drawbacks of using these technologies in their everyday teaching practices. Understanding these experiences is particularly important because contextual factors such as teacher preparedness, infrastructure, technical support, and resource availability may influence the successful implementation of IWBs in mathematics education.

Consequently, drawing on findings from a larger study examining teachers' dispositions towards using IWBs in teaching Euclidean geometry, this paper reports on the affordances and drawbacks of using IWBs in teaching Grade 10 mathematics.' By exploring both the opportunities and the challenges associated with IWB integration, this study contributes to understanding how teachers experience digital technologies in resource-constrained mathematics classrooms. Such knowledge may inform teacher professional development programs, strengthen technology integration initiatives, and support the implementation of learner-centered mathematics instruction within South African schools.

The study was guided by the following research questions:

- What are Grade 10 mathematics teachers' views about the affordances of integrating IWBs in the classroom?
- What are the drawbacks of using IWBs for Grade 10 mathematics teachers?

Literature Review

Interactive Whiteboards as Tools for Learner-Centered Mathematics Education

Globally, researchers have increasingly recognized IWBs as important educational technologies that enhance teaching and learning, particularly in mathematics classrooms (Kearney et al., 2018; Samsonova, 2021; Tan et al., 2015). IWBs integrate a computer, projector, and large

touch-sensitive board, enabling teachers and learners to interact directly with digital content. This interactive functionality creates opportunities for learner-centered instruction by encouraging learners to engage actively with mathematical concepts through visualization, exploration, discussion, and collaborative problem-solving. Rather than merely presenting information, IWBs support inquiry-based learning by enabling learners to investigate mathematical relationships, manipulate multiple representations, and receive immediate feedback during classroom activities.

From an Activity Theory perspective, IWBs function as mediating artifacts that shape interactions between teachers, learners, and mathematical knowledge (Engeström, 1987). They transform the traditional subject-object relationship by enabling abstract mathematical concepts to be explored through dynamic and multimodal representations. Consequently, the use of IWBs extends beyond technological innovation, influencing how teaching and learning activities are organized in mathematics classrooms.

Affordances of Interactive Whiteboards in Mathematics Instruction

Research consistently highlights several pedagogical affordances associated with integrating IWBs into mathematics instruction. Tan et al. (2015) demonstrated that IWBs enable teachers to embed animations of algebraic transformations, thereby improving learners' conceptual understanding and retention. Similarly, Bakadam and Asiri (2012) found that the ability to switch seamlessly between graphs, diagrams, images, and symbolic notation enhanced learners' mathematical reasoning and problem-solving accuracy. These affordances enable teachers to present mathematical ideas through multiple representations, supporting learners in constructing conceptual understanding rather than memorizing procedures.

The integration of mathematical applications such as GeoGebra further strengthens the instructional value of IWBs. Previous studies have reported that GeoGebra enables teachers to demonstrate mathematical concepts dynamically while increasing learner participation and exploration (De Vita et al., 2018a; Gökçe & Güner, 2022; Mokotjo et al., 2021). Studies have consistently suggested that IWBs promote learner-centered mathematics instruction by enabling learners to manipulate mathematical representations, engage in collaborative discussions, and explore mathematical concepts through inquiry-oriented activities (De Vita et al., 2018a; Gökçe & Güner, 2022; Mokotjo et al., 2021). These studies indicate that the pedagogical value of IWBs extends beyond visual presentation by creating opportunities for learners to test mathematical ideas, justify their reasoning, and construct conceptual understanding collaboratively. However, relatively little is known about whether these affordances are experienced similarly within resource-constrained South African township schools, where contextual factors may shape classroom implementation differently.

Multimodal instruction represents another significant affordance of IWBs. Sinclair et al. (2022) reported that combining video demonstrations, digital drawing tools, interactive manipulation, and visual representations enhance learner engagement and improve lesson quality. The findings of the present study extend this understanding by demonstrating that successful IWB integration depends not only on the technology itself but also on teachers' pedagogical

competence in designing interactive and visually rich learning experiences. Within an Activity Theory framework, these affordances illustrate how mediating artifacts reshape classroom activities by promoting greater learner participation and shared responsibility for learning.

Teacher Professional Development and Technology Integration

Although IWBs provide considerable pedagogical opportunities, their successful integration depends largely on teachers' technological competence, pedagogical confidence, and professional development. Previous studies indicate that insufficient training often limits teachers' ability to exploit the interactive capabilities of IWBs, resulting in technology being used primarily for presentation rather than meaningful learner engagement (Bidaki & Mobasheri, 2013; Nikolopoulou & Gialamas, 2016). Effective professional development should, therefore, extend beyond technical training to include pedagogical strategies that enable teachers to facilitate learner-centered and inquiry-based mathematics instruction.

Recent research suggests that sustained professional development should combine technical training with opportunities for collaborative lesson planning, peer mentoring, and reflective practice, enabling teachers to integrate digital technologies confidently within learner-centered mathematics classrooms (Kearney et al., 2018; Engelbrecht & Borba, 2024). Nevertheless, there remains limited evidence regarding how teachers in South African township schools develop these competencies under resource-constrained conditions, highlighting the need for further empirical investigation.

South African Contextual Constraints

The South African education context presents unique opportunities and challenges for the implementation of IWBs. Public schools frequently experience shortages of textbooks, aging technological infrastructure, and recurring electricity disruptions that affect the effective use of educational technologies (Lambert, 2019; Kgosi et al., 2023). In addition, classrooms are characterized by considerable linguistic, cultural, and socio-economic diversity, requiring teachers to employ differentiated instructional approaches that accommodate learners with diverse educational needs (Goyibova et al., 2025). Although national ICT policies encourage the integration of digital technologies into teaching and learning, implementation remains inconsistent because of inequalities in infrastructure, institutional support, and teacher preparedness (Dlamini, 2022).

Technical problems, software updates, unreliable internet connectivity, limited technical support, and load shedding continue to constrain teachers' effective use of IWBs (Department of Basic Education, 2022; Department of Communications and Digital Technologies, 2022; Kgosi et al., 2023). These challenges create tensions between the educational potential of IWBs and the realities of classroom practice. From an Activity Theory perspective, these tensions reflect contradictions within the activity system, in which institutional rules, available resources, and technological tools do not always align with the intended objectives of mathematics teaching. Collectively, these contextual challenges illustrate that technology integration within South African mathematics classrooms cannot be understood solely in terms

of technological availability. Rather, infrastructural reliability, institutional support, teacher preparedness, and access to technical assistance interact to influence how digital technologies are implemented in practice. Understanding how teachers navigate these contextual realities remains an important area for empirical investigation, particularly within township schools where such constraints are most pronounced.

Research Gaps

Research has consistently demonstrated that digital technologies can enhance mathematics teaching by supporting visualization, multiple representations, learner participation, and collaborative problem-solving. Recent reviews further argue that digital technologies are transforming mathematics classrooms by reshaping teachers' instructional practices, learners' engagement, and the design of mathematical learning environments (Engelbrecht & Borba, 2024; Weigand et al., 2024).

Within this broader digital landscape, IWBs have been identified as pedagogical tools that facilitate dynamic visualization, multimodal instruction, and collaborative learning in mathematics classrooms (De Vita et al., 2018a, 2018b). Nevertheless, evidence accumulated over the past decade suggests that teachers frequently use IWBs as presentation devices rather than exploiting their interactive capabilities for inquiry-based mathematics learning (De Vita et al., 2014; Karsenti, 2016).

More recent research continues to demonstrate the educational potential of IWBs while emphasizing that successful implementation depends on teachers' pedagogical competence, institutional support, and technology acceptance rather than on the availability of the technology alone (Gallego et al., 2024; Skordialos, 2024).

Despite this growing body of literature, three important gaps remain. First, most studies have been undertaken in Europe, Asia, and other well-resourced educational systems, with comparatively limited empirical evidence from South African township schools, where persistent challenges such as unreliable infrastructure, limited technical support, and electricity disruptions shape classroom practices. Second, previous research has predominantly examined either the educational benefits of IWBs or the barriers to implementation. At the same time, relatively few studies have explored how teachers simultaneously experience both the affordances and the drawbacks of using IWBs in everyday mathematics teaching. Third, although Activity Theory has frequently been applied to understand technology-mediated learning, it has seldom been used to explain how the interactions among teachers, learners, technological tools, institutional rules, community support, and the division of labor collectively influence the implementation of IWBs in resource-constrained mathematics classrooms.

Addressing these gaps, this study explores Grade 10 mathematics teachers' perceptions of both the affordances and the drawbacks of using IWBs in township secondary schools through the lens of Activity Theory. By examining technology integration as a socio-cultural activity rather than merely the adoption of digital equipment, the study contributes to a deeper understanding of how contextual conditions shape technology-enhanced mathematics teaching.

Research Methodology

Research Paradigm and Design

This study adopted a qualitative research paradigm to explore Grade 10 mathematics teachers' experiences with the use of IWBs in classroom instruction. Qualitative research is appropriate for investigating phenomena as they naturally occur and for understanding participants' experiences, perceptions, and meanings within their real-life contexts (Aspers & Corte, 2019). The study employed a descriptive qualitative research design to describe the affordances and drawbacks teachers experienced when integrating IWBs into mathematics instruction, without attempting to manipulate variables or establish causal relationships.

A qualitative descriptive approach was considered appropriate because the study aimed to provide a rich account of teachers' experiences with IWBs and how these experiences shaped their classroom practices. The study was further informed by Activity Theory, which provided a socio-cultural lens for understanding how institutional rules, available resources, professional practices, and the broader school context influenced teachers' interactions with IWBs. Consequently, the research design enabled an in-depth exploration of both the opportunities and the challenges associated with integrating IWBs into Grade 10 mathematics classrooms.

Research Context

The study focused on Grade 10 mathematics teachers because Grade 10 represents a critical transition into South Africa's Further Education and Training (FET) phase, where learners encounter increasingly demanding subject-specific curricula that influence their progression towards the National Senior Certificate. Research indicates that Grade 10 has one of the highest repetition and dropout rates within the South African schooling system, with nearly one in four learners repeating the grade (Masweneng, 2021). This "gatekeeping" effect disproportionately affects learners attending under-resourced schools and contributes to persistent educational inequalities (Zero Dropout Campaign, 2023).

Departmental statistics further indicate that approximately 80.7% of learners remain enrolled in Grade 10, after which learner attrition increases substantially (Business Tech, 2023). In addition, insufficient alignment between the General Education and Training (GET) and FET phases often leaves teachers addressing considerable academic and developmental gaps among learners (Mabizela, 2019). These contextual factors underscore the importance of understanding how Grade 10 mathematics teachers use digital technologies, such as IWBs, to support teaching and learning in resource-constrained educational environments.

The study was conducted in five public township secondary schools in an urban district of South Africa. These schools had implemented IWBs in their mathematics classrooms, providing an appropriate setting for exploring teachers' experiences of technology integration within the realities of township education.

Participants and Sampling

Purposive sampling was used to select participants with relevant experience in teaching mathematics using IWBs. Purposive sampling is appropriate in qualitative research because it enables researchers to recruit participants who are knowledgeable about the phenomenon under investigation and can, therefore, provide rich, meaningful information.

Ten mathematics teachers from five public township secondary schools participated in the study. To ensure that participants could provide informed perspectives on the use of IWBs, the following criteria were applied:

- participants were required to be Grade 10 mathematics teachers;
- participants were required to have used IWBs for mathematics instruction for at least one year;
- participants were required to have received training in the use of IWBs for teaching mathematics.

Mathematics heads of department at the participating schools assisted in identifying teachers who met these criteria. All identified teachers voluntarily agreed to participate in the study after receiving information about its purpose and ethical requirements. The demographic characteristics of the participants are presented in Table 1.

Table 1.

Profiles of Participants Involved in One-on-One Semi-Structured Interviews

Teacher	School	Level of Education	Years of Instruction	Training in Using IWBs
Teacher A	School 1	Honors in Mathematics Education	17	Yes
Teacher B	School 1	Bachelor of Education (Mathematics)	10	Yes
Teacher A	School 2	Diploma in Mathematics Education	15	Yes
Teacher B	School 2	Bachelor of Education (Mathematics)	10	Yes
Teacher A	School 3	Master of Mathematics Education	25	Yes
Teacher B	School 3	Bachelor of Education (Mathematics)	10	Yes
Teacher A	School 4	Honors in Mathematics Education	10	Yes
Teacher B	School 4	Bachelor of Education (Mathematics)	10	Yes
Teacher A	School 5	Bachelor of Mathematics Education	5	Yes
Teacher B	School 5	Bachelor of Mathematics Education	10	Yes

Although the sample comprised only 10 participants, this was considered appropriate for a qualitative descriptive study, in which the objective is to obtain rich descriptions rather than statistical generalization. The selected participants had substantial teaching experience and direct knowledge of integrating IWBs into Grade 10 mathematics classrooms, enabling them to provide detailed insights into both the affordances and drawbacks of the technology.

Data Collection

Data were collected over five months (May to September) through 10 individual semi-structured interviews. Semi-structured interviews were selected because they allowed the researchers to obtain detailed descriptions of teachers' experiences while maintaining sufficient flexibility to probe issues that emerged during the interviews. An interview guide was developed to ensure consistency across all interviews while allowing participants the opportunity to elaborate on their responses.

The interview questions explored participants' backgrounds in teaching mathematics using IWBs, their experiences with the technology's affordances and drawbacks, the professional development they had received, and the challenges they encountered during classroom implementation. Five interviews were conducted face-to-face outside normal school hours, while the remaining five were conducted online using Microsoft Teams to accommodate participants' schedules.

Each interview lasted approximately 15 minutes. Although relatively brief, the interviews were designed to focus specifically on the research questions and participants' experiences of IWB integration. Similar interview durations have been successfully employed in qualitative educational research, where the research objectives are clearly defined and participants possess extensive experience with the phenomenon under investigation (Creswell & Poth, 2018).

The sample size was guided by the principle of data saturation rather than statistical representativeness (Schreier, 2018). During data collection, recurring patterns and themes became evident across participants' responses, with subsequent interviews yielding little that was substantially new. This indicated that sufficient data had been collected to address the research questions and provide a comprehensive understanding of teachers' experiences with using IWBs in Grade 10 mathematics classrooms.

Data Analysis

The qualitative data were analyzed using an inductive-deductive thematic analysis approach guided by Braun and Clarke's (2006) six-phase framework. This approach was considered appropriate because it allowed themes to emerge from participants' experiences while also enabling interpretation through the conceptual lens of Activity Theory (Naeem et al., 2023). The inductive process ensured that the findings remained grounded in participants' accounts, whereas the deductive process enabled the interpretation of emerging themes within the broader theoretical framework.

Table 2.

Stages of Thematic Analysis (Adapted from Braun and Clarke, 2006, p. 87)

Stage Number	Stages	Description of Analysis Process
1	Familiarizing with data	• Preparing a narrative by transcribing data • Re-reading the material and making a list of early thoughts
2	Generating initial codes	• Coding essential data elements in a systematic way over the whole data collection • Compiling information about each code
3	Searching for themes	• Putting together a list of possible themes based on the codes • Obtaining all pertinent information about each likely candidate
4	Reviewing themes	• Examining the compatibility of themes with coded extracts • Examining the themes to determine if they are appropriate across the dataset • Identifying new themes by analyzing the data • Making a theme map for the analysis
5	Definition and naming of themes	• Continuous assessment to fine-tune the details of each theme, as well as the overall narrative of the investigation • Identifying and establishing the precise titles and descriptions of each theme
6	Producing the report	• This is the final stage of the analysis • The final analysis of carefully selected excerpts linked to the study question, objectives, and reviewed literature

Interview recordings were transcribed verbatim immediately after data collection. Researchers repeatedly read the transcripts to familiarize themselves with the data and to identify initial patterns relevant to the research questions. During this familiarization stage, preliminary observations and reflective notes were recorded to support the subsequent coding process.

The interview transcripts were then imported into ATLAS.ti qualitative data analysis software to facilitate systematic coding, organization, and retrieval of the data. Initially, open coding was undertaken inductively by assigning descriptive codes to meaningful units of text based on participants' own words and experiences, as suggested by Pearse (2019). For example, the statement *"The interactive whiteboard sometimes slows me down because it takes a long time*

to load" was coded as a technical barrier, whereas *"Learners are more engaged when I use visuals on the board"* was coded as enhanced learner engagement.

Following the initial coding process, related codes were systematically compared and grouped into broader categories using the organizational features available within ATLAS.ti. For example, codes such as technical barriers, lack of training, and inconsistent internet connectivity were combined under the broader category of drawbacks. In contrast, enhanced learner engagement, visual learning support, and interactive participation were grouped within the category of affordances. Throughout this iterative process, similar codes were refined, merged, or removed where overlap occurred, ensuring that each category accurately represented participants' experiences.

The network view function within ATLAS.ti was further used to examine relationships among codes and categories. This visual mapping process helped identify patterns, contradictions, and connections among emerging themes. For instance, teachers frequently described IWBs as promoting learner engagement while also noting time delays caused by technical difficulties. These contrasting experiences informed the interpretation of the broader themes relating to both the affordances and drawbacks of IWB use.

The final themes were developed through continuous comparison of coded extracts and repeated engagement with the data. Throughout the analysis, the researchers refined the names, definitions, and boundaries of each theme to ensure that they accurately represented participants' experiences and addressed the research questions. In total, approximately 100 initial codes were generated. During the refinement stage, categories with similar meanings were combined to produce broader and more meaningful themes. For example, the "*great tools for construction*" and "*help in drawing*" were merged into a broader theme of visualization and multimedia, thereby improving conceptual clarity (Azungah, 2018).

Although the themes emerged inductively from participants' accounts, their interpretation was informed by Activity Theory. This theoretical lens enabled the researchers to examine how teachers' experiences were shaped by interactions among mediating artifacts (IWBs), institutional rules, available resources, the school community, and the division of labor within the mathematics classroom. Consequently, the analysis moved beyond simple description by explaining how contextual conditions influenced teachers' experiences of integrating IWBs into mathematics instruction.

Trustworthiness

The trustworthiness of the study was established using strategies to enhance credibility, dependability, confirmability, and transferability. Credibility was strengthened through member checking, in which participants reviewed their interview transcripts and the researchers' interpretations to verify that their experiences were accurately represented. Any transcription errors or factual inaccuracies identified by participants were corrected before the final analysis.

Dependability was promoted by maintaining a clear audit trail throughout the research process. The interview guide, coding procedures, analytical decisions, and theme development were documented systematically to ensure transparency and consistency during the analysis.

Confirmability was enhanced through peer review and researcher reflexivity. The researchers maintained reflective journals throughout the study to examine personal assumptions, minimize researcher bias, and ensure that the findings were grounded in participants' accounts rather than the researchers' interpretations. In addition, peer discussions on coding decisions and theme development further strengthened the analysis's consistency.

Transferability was supported using thick description. Detailed descriptions of the research context, participant characteristics, and findings enable readers to determine the extent to which the findings may apply to similar educational settings. Rather than merely reporting participants' responses, the findings were interpreted within the broader institutional and educational context in which the teachers used IWBs.

Ethical Considerations

Ethical approval for the study was obtained from the university responsible for overseeing the research (Sem 1-2020-031). Permission to conduct the study was obtained before data collection commenced.

All participants were informed about the purpose of the study, the voluntary nature of their participation, and their right to withdraw from the research at any stage without penalty. Written informed consent was obtained from each participant prior to participation.

Confidentiality and anonymity were maintained throughout the study. Pseudonyms were used to protect the identities of both the participating schools and the teachers. The five participating schools were identified as Schools A, B, C, D, and E, and participants were assigned numerical pseudonyms (Participants 1–10). All interview data were treated confidentially and used exclusively for research purposes.

Results

The recorded interviews were transcribed verbatim and analyzed using thematic analysis in ATLAS.ti. The coding process generated two overarching themes: (i) the perceived affordances of IWBs and (ii) the perceived drawbacks associated with their use in Grade 10 mathematics classrooms. These themes, together with their categories and representative codes, are presented in Table 3.

The findings are presented through the lens of Activity Theory, which conceptualizes teachers as subjects who use IWBs as mediating artifacts to achieve the object of effective mathematics teaching. The findings illustrate how teachers experienced both enabling and constraining factors while integrating IWBs into classroom practice.

Research Question 1: What are Grade 10 mathematics teachers' views about the affordances of IWBs in the classroom?

Participants perceived IWBs as providing several pedagogical affordances that supported learner engagement, interaction, and conceptual understanding in mathematics classrooms. The analysis revealed three interrelated affordances of using IWBs in Grade 10 mathematics classrooms: (i) increased learning, (ii) improved mathematics instruction, and (iii) multimodal teaching and learning. Therefore, IWBs, as an educational technology tool, provide a wealth of affordances that make learning dynamic and exciting when combined with traditional blackboards, especially in mathematics, as evidenced by the data analyzed.

(i) Enhanced Learning

Teachers consistently described IWBs as valuable instructional tools that promoted learner engagement, participation, conceptual understanding, and confidence. Participants explained that the interactive features of IWBs enabled learners to become active participants during mathematics lessons rather than passive recipients of information.

Participant 1B described the learning environment created through IWBs as:

"The IWB promoted a dynamic and captivating learning environment, especially for learners with short attention spans."

Similarly, Participant 3A explained:

"Learners comprehend the content through activities."

Teachers further indicated that IWBs accommodated different learning preferences by integrating visual, auditory, and kinesthetic approaches. Participant 3B commented:

"Children not only can watch and listen, but they can also touch and move objects."

Collectively, these responses indicate that teachers perceived IWBs as enhancing learner engagement, conceptual understanding, and confidence through interactive and learner-centered mathematics instruction.

(ii) Improved Instruction

Beyond promoting learner engagement, participants also described how IWBs enhanced lesson preparation and mathematics instruction. IWBs did so by enabling teachers to incorporate dynamic mathematical software, interactive demonstrations, and collaborative activities. Several teachers indicated that applications such as GeoGebra and Geometer's Sketchpad, improved the teaching of geometry by allowing learners to visualize mathematical concepts.

Participant 2B explained:

"Collaboration helps students to share knowledge with other learners on an IWB platform."

Participant 1A described how IWBs extended learning beyond the classroom:

"...a teacher could send information even to students' gadgets...teaching could continue even when we are not in the same space."

However, some participants noted that inconsistencies in software availability limited these instructional opportunities. For example, Participant 2A reported difficulties when GeoGebra was unavailable on some IWBs.

Overall, participants reported that IWBs enhanced lesson preparation, promoted collaborative learning, supported creativity, and facilitated the teaching of abstract mathematical concepts through dynamic visualization.

(iii) Multimodal Methods

In addition to improving instruction, participants highlighted the value of IWBs for multimodal teaching and learning by integrating text, images, animations, videos, and digital learning resources into mathematics lessons. Participants indicated that these features enriched classroom discussions and increased learner interest.

Participant 4B stated:

"I can look for information easily…it enriches the classroom discussions."

Participant 3B noted that learners were able to create:

"Beautiful and very creative diagrams and shapes."

Teachers further explained that storing electronic textbooks on IWBs improved learners' access to learning resources. Participant 1A remarked:

"Those without access to the textbook can always come to me...and I can easily open the book for them on the IWB."

These findings indicate that teachers viewed IWBs as supporting multiple modes of teaching and learning while expanding learners' access to digital educational resources.

Research Question 2: What are the drawbacks of using IWBs for Grade 10 mathematics teachers?

Despite recognizing the educational value of IWBs, participants also identified several barriers that constrained their effective use in the classroom. According to Williamson et al. (2023), every educational technology tool has its difficulties and flaws, regardless of how promising or advantageous it is. Disregarding or minimizing the disadvantages of using IWBs can lead to distorted viewpoints and insufficient understanding of their use in mathematics instruction. Two categories of drawbacks emerged from the analysis: (i) technical issues and (ii) teacher-related challenges. These emerged primarily in relation to tools, rules, and the division of labor, which hindered teachers' capacity to fully realize enhanced mathematics learning.

(i) Technical Issues

Technical challenges emerged as one of the principal barriers to effective IWB integration. Participants frequently reported freezing screens, unreliable internet connectivity, software incompatibility, and load shedding as factors that disrupted mathematics lessons and reduced instructional time.

Participant 4A explained:

"The board freezes a lot, and we have to always resort to using the normal board."

Participant 1B further described the effect of load shedding:

"...if you have to wait for the IWB...you are going to miss the time allocated for you."

Participant 3A summarized the technical difficulties experienced:

"Most problems I encountered were technical problems, load shedding, and sometimes a lack of knowledge on how to use certain tools."

These responses demonstrate that technical limitations reduced the reliability of IWBs and frequently disrupted mathematics instruction.

(ii) Teacher Challenges

Participants also identified teacher-related challenges that influenced the effective integration of IWBs. These included insufficient technological knowledge, limited professional development, uncertainty about integrating digital technologies into mathematics lessons, and resistance to adopting new technologies.

Participant 5A explained:

"...most students do not know how to use these technological tools, which in turn affects teachers from asking learners to use technologies also. We demonstrate and request that students participate in the IWB."

Participant 1A acknowledged teachers' own limitations:

"...teachers are not as conversant with teaching geometry through technology."

Participants consistently indicated that the available professional development was insufficient. Participant 2A commented:

"That training of two to three days can never be sufficient."

Participant 1B further observed:

"...people who cannot use a gadget are always scared to experiment."

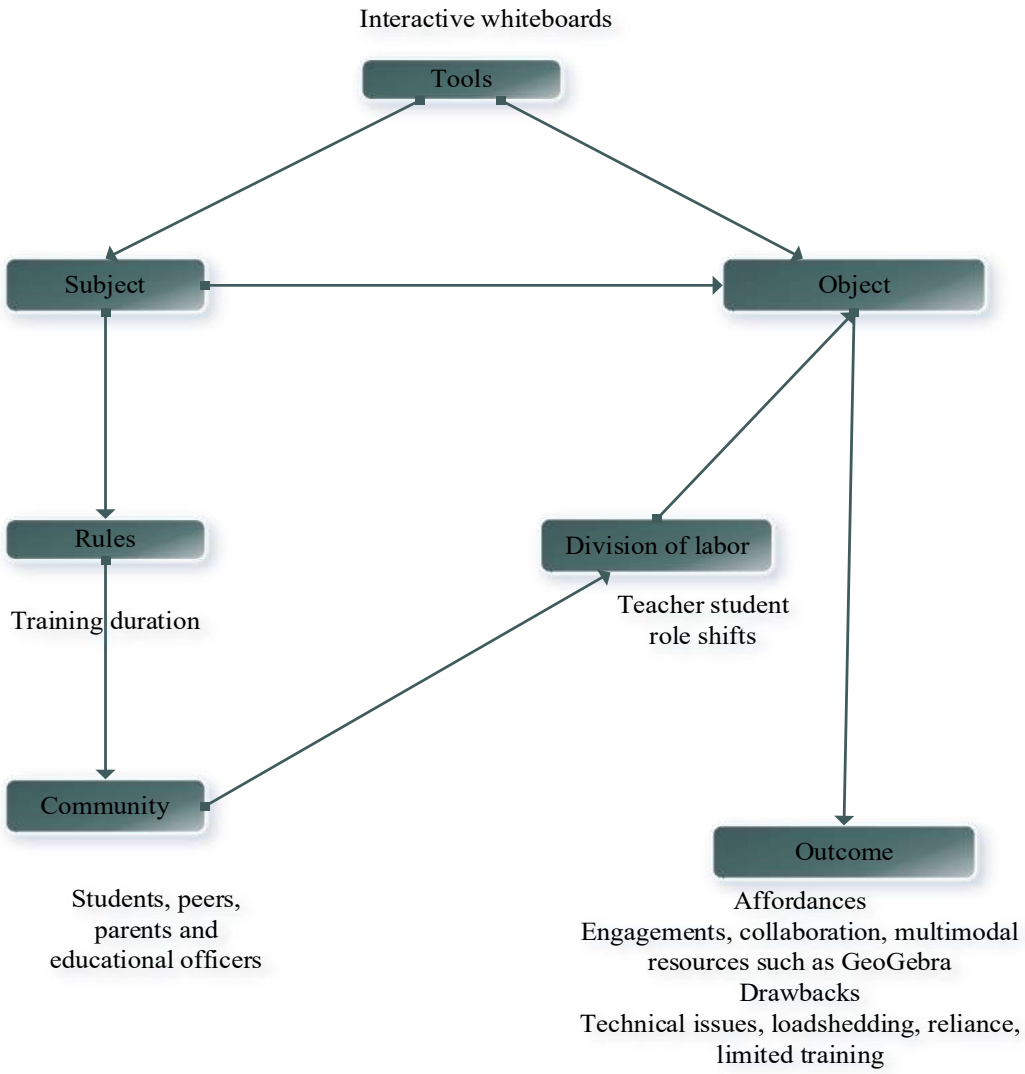
Collectively, these findings suggest that teachers regarded professional development, technological competence, and institutional support as critical factors influencing the effective use of IWBs in mathematics classrooms.

Activity Theory

Figure 1 provides a conceptual representation of how the affordances and challenges identified in this study relate to the components of Activity Theory. It illustrates the interactions between teachers (subjects), IWBs (mediating artifacts), the object of mathematics teaching and learning, and the institutional context within which technology integration occurred.

Figure 1.

Activity Theory Framework for IWBs in Mathematics Classrooms



Discussion of Findings

The findings indicate that Grade 10 mathematics teachers perceived IWBs as valuable pedagogical tools that supported learner-centered mathematics instruction. Rather than functioning merely as presentation technologies, IWBs were perceived to facilitate mathematical visualization, collaborative learning, multimodal instruction, and learner participation. These affordances suggest that teachers viewed IWBs as enabling more interactive forms of mathematics teaching consistent with inquiry-oriented pedagogical practices. Similar findings have been reported in studies demonstrating that digital technologies enhance mathematics learning when integrated within meaningful pedagogical approaches rather than being used solely for information delivery (De Vita et al., 2018b; Engelbrecht & Borba, 2024; Weigand et al., 2024).

Affordances of Integrating Interactive Whiteboards into Mathematics Classrooms

The findings demonstrate that Grade 10 mathematics teachers perceived IWBs as valuable pedagogical tools that support learner-centered and inquiry-based mathematics instruction. Teachers consistently described IWBs as facilitating visualization, learner participation, collaboration, and multimodal learning, thereby enabling learners to engage more actively with mathematical concepts. Rather than functioning solely as presentation technologies, IWBs were perceived as instructional tools that promoted conceptual understanding by allowing learners to manipulate mathematical representations, interact with digital resources, and participate in collaborative classroom activities. These findings reinforce previous research showing that digital technologies can enhance mathematics learning when integrated into pedagogically meaningful instructional practices rather than being used merely for information delivery (De Vita et al., 2018b; Engelbrecht & Borba, 2024; Weigand et al., 2024). Viewed through the lens of Activity Theory (Engeström, 1987, 2001), these findings suggest that the IWB served as a mediating artifact, enabling teachers (subjects) to pursue the shared object of improving mathematics teaching and learning. Rather than acting independently, the technology facilitated interactions among teachers, learners, mathematical content, and classroom practices, thereby creating opportunities for more learner-centered and inquiry-oriented mathematics instruction.

One of the most significant affordances identified by participants was IWBs' ability to improve mathematical visualization. Teachers reported that applications such as GeoGebra enabled learners to observe geometric constructions dynamically, manipulate mathematical objects, and explore relationships among mathematical concepts. Such opportunities extend beyond traditional chalk-and-board instruction, making abstract concepts visible and interactive. From an Activity Theory perspective, GeoGebra and the IWB served as mediating artifacts that transformed teachers' instructional practices by making abstract mathematical concepts more accessible through dynamic visual representations. This mediation supported learners' exploration of mathematical relationships and encouraged inquiry by enabling them to manipulate and observe mathematical objects in real time. This finding supports previous studies that identified dynamic mathematical software as an effective means of improving conceptual understanding and mathematical reasoning (Gökçe & Güner, 2022; Mokotjo & Mokhele, 2021). However, the present study extends this literature by demonstrating that these pedagogical benefits are achievable even within township schools where technological resources are often constrained. This suggests that the educational value of IWBs depends not solely on the technology itself but on teachers' ability to integrate digital tools into meaningful mathematical inquiry.

Participants also emphasized that IWBs promoted learner participation and collaborative learning by encouraging learners to interact directly with mathematical content, discuss solutions, and share ideas during lessons. These findings align with studies demonstrating that interactive technologies foster collaborative knowledge construction and learner engagement through shared exploration of mathematical concepts (Warwick & Kershner, 2008; Shi et al., 2021). Activity Theory further suggests that learning occurs through social interaction within a community. In this study, the IWB facilitated collaborative engagement between teachers and

learners by creating opportunities for discussion, shared problem-solving, and collective mathematical reasoning. These interactions illustrate how the mediating artifact supported the community component of the activity system while promoting learner-centered participation. Unlike studies conducted in technologically advanced educational systems, however, the present findings illustrate how collaborative learning can emerge despite infrastructural limitations when teachers intentionally design interactive classroom activities. Consequently, learner engagement should be understood not as an inherent property of the technology but as an outcome of effective pedagogical practice.

The findings further demonstrate that teachers valued the multimodal capabilities of IWBs because they enabled the integration of diagrams, videos, animations, digital textbooks, and online learning resources into mathematics lessons. These multiple representations accommodated diverse learning preferences while enriching classroom discussions and supporting conceptual understanding. Within the Activity Theory framework, these multimodal resources expanded the range of mediating tools available to teachers, enabling them to present mathematical concepts through multiple representations that accommodated diverse learner needs. This flexibility supported differentiated instruction and encouraged learners to engage with mathematical ideas through visual, symbolic, and interactive representations. Previous studies have similarly argued that multimodal instruction enhances mathematical communication and learner engagement by presenting concepts through complementary visual, textual, and interactive representations (Sinclair et al., 2022; Morell, 2018). The present study provides additional evidence by showing that multimodal teaching is particularly valuable in resource-constrained schools, where access to printed learning materials may be limited, thereby broadening learners' access to educational resources through digital platforms.

From the perspective of Activity Theory, these findings demonstrate that IWBs functioned as mediating artifacts that transformed the relationship between teachers (subjects) and the object of improving mathematics teaching and learning. Rather than acting independently, the technology operated within a broader activity system that included learners, school communities, institutional rules, available resources, and the division of labor within classrooms (Engeström, 1987; Engeström, 2001). The pedagogical affordances identified by participants emerged through the interaction of all components of the activity system rather than from the technology itself. Teachers (subjects) used IWBs (mediating artifacts) to achieve the object of improving mathematics teaching and learning, while learners, colleagues, and school leadership constituted the community that supported classroom implementation. At the same time, institutional policies, curriculum expectations, and available technological infrastructure represented the rules governing classroom practice, whereas teachers and learners assumed complementary roles within the division of labor. The effectiveness of IWBs, therefore, depended on the alignment of these interacting components rather than on technological availability alone, illustrating that successful technology integration is fundamentally a socio-cultural process. This interpretation strengthens existing research by illustrating that successful technology integration is fundamentally a socio-cultural process in which pedagogical

competence, institutional support, and contextual conditions collectively determine whether the potential of digital technologies is realized.

Challenges of Integrating Interactive Whiteboards into Mathematics Classrooms

Although participants recognized the considerable pedagogical value of IWBs, they also identified several contextual and institutional barriers that constrained their effective integration into mathematics teaching. The findings indicate that the successful implementation of IWBs extends beyond the availability of technological equipment and depends on the interaction of multiple organizational, infrastructural, and pedagogical factors. The principal challenges identified by participants included unreliable internet connectivity, software incompatibility, hardware malfunctions, recurring electricity disruptions, insufficient professional development, and limited technological confidence among some teachers. These findings reinforce previous research demonstrating that technology integration is a complex educational process influenced by institutional capacity, teacher competence, and contextual conditions rather than by access to digital technologies alone (Karsenti, 2016; Nikolopoulou et al., 2022; Engelbrecht & Borba, 2024). Viewed through Activity Theory (Engeström, 1987, 2001), these findings indicate that the successful integration of IWBs depends on the interaction between teachers (subjects), the shared object of improving mathematics teaching and learning, the IWB as the mediating artifact, and the institutional context within which teaching occurs. Consequently, challenges affecting technology integration should be understood as disruptions within the broader activity system rather than as isolated technological problems.

Technical challenges emerged as one of the most significant barriers to effective mathematics instruction using IWBs. Participants reported that internet failures, frozen screens, software updates, and load shedding frequently interrupted lessons, resulting in lost instructional time and forcing teachers to revert to conventional teaching methods. Similar barriers have been reported internationally, where inadequate technical infrastructure continues to limit teachers' ability to exploit the full pedagogical capabilities of educational technologies (Karsenti, 2016; Nikolopoulou et al., 2022). However, the present study extends this body of knowledge by illustrating how these challenges are intensified within South African township schools, where persistent electricity disruptions and infrastructural inequalities create additional obstacles that are less commonly reported in well-resourced educational systems. These contextual realities suggest that investments in classroom technologies alone are insufficient unless accompanied by reliable supporting infrastructure. From an Activity Theory perspective, unreliable internet connectivity, software failures, and electricity disruptions represent contradictions between the mediating artifact (the IWB) and the institutional rules and resources that govern classroom practice. These contradictions interrupted teachers' ability to achieve the object of promoting learner-centered mathematics instruction, forcing them to revert to traditional teaching approaches despite recognizing the pedagogical value of IWBs.

Professional development emerged as a second critical factor influencing teachers' use of IWBs. Although all participants had received some form of training, they consistently regarded the available professional development as inadequate for developing the technological and

pedagogical competencies required to integrate IWBs effectively into mathematics instruction. Participants emphasized that short introductory workshops did not provide sufficient opportunities to develop confidence in using mathematical software, managing technological challenges, or designing learner-centered digital lessons. These findings are consistent with previous studies indicating that effective technology integration depends not only on technical skills but also on teachers' pedagogical knowledge and sustained professional learning opportunities (Bidaki & Mobasheri, 2013; Kearney et al., 2018). Consequently, professional development should move beyond one-off technical training towards continuous programs that incorporate collaborative lesson design, classroom mentoring, peer learning, and reflective practice. Within the Activity Theory framework, professional development strengthens teachers' capacity as subjects to use the IWB effectively as a mediating artifact. Continuous learning enables teachers to resolve contradictions arising from limited technological knowledge. It supports the development of pedagogical practices that align with the shared object of meaningful, learner-centered mathematics learning.

The findings also demonstrate that teachers' technological confidence influenced the extent to which IWBs were integrated into classroom practice. Participants acknowledged that uncertainty regarding digital tools discouraged experimentation and limited the pedagogical use of available technologies. Teachers who lacked confidence were more likely to use IWBs primarily to present information than to facilitate interactive mathematical investigations. This finding supports research showing that teachers' beliefs, self-efficacy, and digital competence significantly influence the adoption of educational technologies (Gallego et al., 2024). It also highlights the importance of developing teachers' technological pedagogical knowledge so that digital technologies become integral components of mathematics instruction rather than supplementary presentation devices. Activity Theory suggests that teachers' confidence influences how effectively they engage with mediating artifacts during classroom activity. Where teachers lack technological confidence, the relationship between the subject and the mediating artifact becomes constrained, limiting opportunities for inquiry-based learning and reducing learners' ability to participate actively in mathematical investigations.

An important contribution of the present study is that it demonstrates how these challenges do not operate independently but interact to influence classroom practice. For example, inadequate professional development reduced teachers' confidence in using digital tools, while technical failures discouraged teachers from experimenting with more interactive instructional approaches. Similarly, unreliable internet connectivity limited access to online mathematical resources and constrained the use of applications such as GeoGebra, thereby reducing opportunities for learner-centered instruction. These findings illustrate that barriers to technology integration are interconnected rather than isolated and should, therefore, be addressed through coordinated institutional strategies. These interacting challenges illustrate that contradictions within one component of the activity system frequently influence other components. For example, inadequate institutional support constrained teachers' confidence and use of digital tools, while unreliable infrastructure limited opportunities for collaborative

inquiry-based mathematics learning. Addressing only one barrier is, therefore, unlikely to produce sustainable improvements unless the broader activity system is strengthened.

Activity Theory provides a useful framework for explaining these interactions. Within the activity system, teachers represent the subjects working towards the object of improving mathematics teaching and learning through the mediating artifact of the IWB. However, this process is simultaneously shaped by institutional rules, available resources, the school community, and the division of labor. The technical and organizational barriers identified in the study constitute contradictions within the activity system, as they disrupt the alignment among these components and constrain teachers' ability to achieve their instructional objectives (Engeström, 1987; Engeström, 2001). Consequently, the effectiveness of IWBs cannot be understood solely in terms of technological functionality. Rather, it must also be considered in relation to the broader educational environment within which teachers operate.

From an Activity Theory perspective, the challenges identified in the study emerged from the interaction of all components of the activity system rather than from the technology itself. Teachers (subjects) sought to improve mathematics teaching and learning by using IWBs as mediating artifacts. However, institutional rules, curriculum expectations, infrastructure, and school policies shaped how these technologies could be used in practice, while learners, colleagues, technical personnel, and school leadership formed the community that influenced classroom implementation. The division of labor further determined how responsibilities for technical support, maintenance, and classroom instruction were distributed. Where these components became misaligned, contradictions emerged that constrained teachers' ability to integrate IWBs effectively. These findings, therefore, demonstrate that sustainable technology integration requires alignment across the entire activity system rather than improvements to technological resources alone.

Implications for Mathematics Teaching, School Leadership, and Educational Policy

The findings have several important implications for mathematics education. First, they demonstrate that IWBs can support learner-centered, inquiry-based mathematics instruction by enabling learners to visualize mathematical concepts, participate actively in classroom discussions, collaborate with peers, and explore multiple mathematical representations. However, these pedagogical benefits can only be realized when teachers possess the necessary technological and pedagogical competencies to integrate IWBs meaningfully into classroom practice.

Second, the findings highlight the importance of continuous professional development that focuses not only on technical skills but also on pedagogical strategies for technology-enhanced mathematics teaching. Professional development programs should, therefore, incorporate collaborative lesson design, classroom coaching, peer mentoring, and opportunities for teachers to reflect critically on their classroom practices.

Third, the findings suggest that school leadership plays an important role in supporting the sustainable integration of technology. School management teams should ensure that teachers

receive ongoing technical support, sufficient planning time, and access to functioning digital infrastructure. Institutional commitment to technology integration is essential if schools are to maximize the educational value of investments in IWBs. Accordingly, efforts to enhance the educational impact of IWBs should adopt a systemic perspective that simultaneously addresses technological infrastructure, teacher professional learning, institutional support, and collaborative school practices to create conditions that sustain learner-centered and inquiry-based mathematics instruction.

Finally, the findings have broader policy implications. While national and provincial investments in educational technologies have expanded access to IWBs, the findings indicate that infrastructure development alone is insufficient. Policymakers should consider technology integration as a systemic process requiring simultaneous investment in a reliable electricity supply, internet connectivity, teacher professional development, technical support, and supportive school leadership. Addressing these interconnected factors is likely to improve the sustainability and educational impact of digital technologies within South African mathematics classrooms.

Conclusion and Recommendations

This study explored Grade 10 mathematics teachers' perceptions of the affordances and drawbacks of using IWBs in township secondary schools in South Africa. The findings indicate that teachers generally viewed IWBs as valuable instructional tools that supported learner-centered mathematics teaching by enhancing learner engagement, collaboration, mathematical visualization, multimodal instruction, and access to digital learning resources. However, the study also revealed that the effective integration of IWBs was constrained by technical problems, inadequate professional development, unreliable infrastructure, and recurring load shedding. These findings demonstrate that the educational value of IWBs depends not only on the availability of technology but also on the broader institutional and contextual conditions within which teaching and learning occur.

From a theoretical perspective, this study contributes to the literature by demonstrating the usefulness of Activity Theory in explaining how interactions among teachers, learners, technological tools, institutional rules, the school community, and the division of labor influence the integration of IWBs into mathematics classrooms. Rather than viewing technology as an isolated intervention, the findings show that successful technology integration is a systemic process shaped by relationships among multiple components of the educational activity system. The study, therefore, extends existing research by demonstrating that the effectiveness of IWBs cannot be explained solely by technological functionality but must be understood through the dynamic interaction of teachers, learners, mediating artifacts, institutional rules, community support, and the division of labor within the educational activity system.

The study also makes an important practical contribution by demonstrating that IWBs can promote learner-centered, inquiry-based mathematics instruction when teachers are adequately supported in their effective use. Teachers reported that IWBs enabled them to create more

interactive learning environments through dynamic mathematical visualization, collaborative activities, and multimodal teaching approaches. However, these pedagogical opportunities can only be fully realized when teachers possess the technological and pedagogical knowledge required to integrate digital technologies meaningfully into classroom practice.

The findings have important implications for educational policy and school leadership. Investments in educational technologies should be accompanied by sustained investment in teacher professional development, reliable technical infrastructure, ongoing technical support, and school leadership that actively promotes technology-enhanced teaching and learning. Providing schools with IWBs alone is unlikely to transform classroom practice unless teachers receive continuous opportunities to strengthen both their technological competence and their pedagogical use of digital tools.

Overall, the findings demonstrate that the successful integration of IWBs requires more than technological investment. Creating sustainable learner-centered and inquiry-based mathematics classrooms depends on aligning technological resources with teacher professional learning, supportive school leadership, reliable infrastructure, and enabling institutional conditions. Such a systemic approach is essential for realizing the educational potential of digital technologies in South African township schools.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

- Continuous professional development programs should be implemented to strengthen teachers' technological and pedagogical competencies for integrating IWBs into mathematics instruction. Professional development should extend beyond short introductory workshops to include classroom-based mentoring, collaborative lesson planning, peer learning, ongoing technical support, professional learning communities, and reflective practice.

- Teacher education institutions and education departments should incorporate learner-centered and inquiry-based approaches to technology integration into both pre-service and in-service mathematics teacher development programs.

- School management teams should establish sustainable technical support systems to minimize disruptions caused by software failures, hardware malfunctions, and connectivity problems. Where possible, schools should ensure that teachers have timely access to technical assistance during classroom instruction.

- Policymakers should recognize that successful technology integration requires investment in supporting infrastructure, including a reliable electricity supply, internet connectivity, software maintenance, and appropriate classroom resources. Addressing these contextual challenges is essential for maximizing the educational benefits of IWBs, particularly within resource-constrained schools.

- Mathematics teachers should be encouraged to engage in continuous professional learning, communities of practice, and self-directed exploration of educational technologies to

strengthen their confidence and competence in integrating IWBs into learner-centered mathematics classrooms.

Limitations and Future Research

This study should be interpreted in light of several limitations. First, the study employed a qualitative descriptive research design involving 10 Grade 10 mathematics teachers from five public township secondary schools within a single urban district in South Africa. Consequently, the findings reflect the perceptions and experiences of participants within this specific educational context and are not intended to be statistically generalized to all mathematics teachers or schools. Nevertheless, the rich contextual descriptions provided may enable readers to determine the transferability of the findings to similar educational settings.

Second, the study explored teachers' perceptions of the affordances and drawbacks of using IWBs rather than directly measuring learner achievement or instructional effectiveness. As a result, any perceived improvements in learner engagement, participation, or understanding reported in this study represent teachers' experiences and perceptions and should not be interpreted as evidence of causal improvements in learner performance.

Third, the study relied solely on semi-structured interview data. Although this approach provided rich insights into teachers' lived experiences, future studies could strengthen the evidence base by adopting mixed-methods or multiple-source designs that combine interviews with classroom observations, learner perspectives, document analysis, or quantitative measures of instructional outcomes. Such approaches would provide a more comprehensive understanding of how IWBs influence learner-centered and inquiry-based mathematics teaching and learning across diverse educational contexts.

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Appendix

Table 3.

Themes, Categories, and Codes from Interviews

Themes	Category	Codes	Participant number
Affordances	Learning	Students understand better	1, 2, 3
		Accurate drawings and making mathematics more engaging	1, 2
		Increased participation	1
		Cater to different learning abilities	1, 2
		Increased collaboration	1, 3, 5, 9
		Increased performance	1
		Increased motivation	1
		Increased interaction	1
		Increased confidence	1, 3, 4, 7
	Instruction	Help teachers' preparedness, planning, and creativity by using GeoGebra	1, 2
		Interesting	1, 2, 3
	Multimodal methods	Great tool for construction	1, 2, 3, 4, 5, 6, 7, 8, 9
		Work can be sent online to the IWB	1
		It can be blended with the traditional board	1
		Helps with e-book	1, 3, 5
		Timesaving	1
Drawbacks	Technical issues	No internet connection	2, 4, 7, 10
		Freezing of the board	1, 3, 5, 7
		Changing versions	1
		Not available in all classes	1, 2, 3

	Load shedding creates uncertainty	1, 6, 8, 10
Teacher challenges	Insufficient knowledge	1, 3, 7, 9, 10
	Lack of training	1, 2, 3, 4, 5
	Uncertainty about presenting content	1, 7, 9, 10