Digital Technology Knowledge and Skills Among Mathematics Teachers in Secondary Schools in Uasin Gishu County, Kenya

Article history: *Revised: 4th August 2026, Published: 23rd November 2026*

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Abstract:

Purpose: *This study examined the level of digital technology knowledge and skills among mathematics teachers in secondary schools in Uasin Gishu County, Kenya. It focused on teachers' training, participation in professional development, overall self-rated digital skills, and competence in using specific digital tools for mathematics teaching.*

Material/methods: *The study adopted a pragmatist philosophy and a convergent parallel mixed methods design. It involved 68 sampled secondary schools. Out of 272 mathematics teachers who were approached, 242 completed usable questionnaires. Semi-structured interviews were also conducted with school principals and Heads of Mathematics Departments to provide additional explanations and context. The results were based on the data reported in the source thesis.*

Findings: *The findings showed that many mathematics teachers had limited formal preparation in digital technology integration. Of the 242 teachers, 144 (60.0%) reported that they had not received training on integrating digital technologies into mathematics teaching. Among the 98 teachers who had received training, only five (5.1%) had been trained in mathematics-specific software and three (3.1%) in Artificial Intelligence tools. In addition, 137 teachers (56.6%) reported that they rarely attended digital technology-related professional development programmes. On the overall skills rating, 126 teachers (52.1%) rated their digital technology skills as low or very low. Although teachers reported strong competence in some specific digital activities, some of the reported mean scores did not match the response percentages shown in the results table.*

Conclusion: *The findings show that many mathematics teachers had limited formal training and infrequent opportunities for professional development in digital technologies.*

Value: *Education agencies and schools should therefore provide regular, practical, and mathematics-specific training that focuses on the use of digital tools in lesson delivery, assessment, learner engagement, and problem-solving. Before making a final conclusion about teachers' overall level of digital competence, the original survey data should be checked to confirm the accuracy of the item means and the overall composite score.*

Keywords: *Mathematics Teachers, Digital Technology Skills, Knowledge, Professional Development, Mathematics Pedagogy*

Paper Type: *Research Article*

Recommended citation: Mulwa, E. C., Momanyi, L., & Chemase, J. (2026). Digital technology knowledge and skills among mathematics teachers in secondary schools in Uasin Gishu County Kenya. *Journal of Economics, Management Sciences and Procurement, 5*(1), 516–531.

1. Introduction

Digital technologies are increasingly transforming mathematics teaching and learning by enabling learners to visualize abstract concepts, explore mathematical relationships, solve problems, and receive immediate feedback during instruction (UNESCO, 2023; Wang et al., 2024). Tools such as graphing software, spreadsheets, dynamic geometry applications, simulations, virtual manipulatives, learning management systems, and artificial intelligence applications can improve conceptual understanding, learner engagement, collaboration, and problem-solving skills (Haleem et al., 2022; Wang et al., 2024). Digital technologies also support collaborative learning, facilitate

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assessment, improve learner participation, and enable teachers to provide timely feedback (Timotheou et al., 2023; Anisyah et al., 2025). However, the effectiveness of these technologies depends largely on whether teachers possess adequate knowledge and skills to select, operate, and integrate them into classroom instruction (UNESCO, 2023; OECD, 2025). Mathematics teachers therefore require digital competencies that enable them to combine technology with mathematical content, appropriate pedagogical strategies, learner assessment, and classroom activities (Padilla-Escorcia et al., 2025; Simsek, 2025).

Digital technology knowledge and skills among mathematics teachers extend beyond basic computer literacy because effective integration requires teachers to understand how particular technologies can support the teaching and learning of specific mathematical concepts (Padilla-Escorcia et al., 2025). The Technological Pedagogical Content Knowledge framework emphasizes that teachers need to combine technological, pedagogical, and content knowledge for meaningful technology-supported instruction (Mishra & Koehler, 2006; Xie & Luo, 2025). In mathematics, such competencies enable teachers to use technology for visualization, mathematical modelling, symbolic manipulation, data analysis, conjecture testing, problem-solving, and assessment (Simsek, 2025; Padilla-Escorcia et al., 2025). Nevertheless, international evidence indicates that many mathematics teachers continue to experience difficulties integrating digital technologies because of inadequate technological and pedagogical competencies (Simsek, 2025; Padilla-Escorcia et al., 2025). Xie and Luo (2025), for example, reported low levels of Artificial Intelligence-Technological Pedagogical Content Knowledge among mathematics teacher education students, while OECD (2025) emphasizes the importance of continuous professional development in strengthening teachers' digital competencies.

Across Africa, increased internet connectivity, mobile technologies, and government investment in digital education have expanded opportunities for integrating technology into mathematics instruction, although teachers' digital knowledge and skills remain uneven (UNESCO, 2023; Mhlanga, 2024). In Zambia, mathematics teacher educators demonstrated moderate technological proficiency despite recognizing the usefulness of digital technologies in teaching (Mukuka, 2025). Studies in South Africa similarly indicate that many teachers appreciate the educational value of technology but lack adequate technological and pedagogical competencies for meaningful classroom integration (Mahlobo, 2021; Maphalala & Adigun, 2021). In Ghana, limited training and inadequate institutional support have constrained mathematics teachers' ability to integrate ICT into instruction (Boateng et al., 2022). Evidence from Botswana further shows that while teachers are generally familiar with basic technologies such as computers and calculators, relatively few possess advanced digital competencies required for mathematics instruction (Thabologo & Keganneng, 2025). These findings suggest that increased availability of digital infrastructure has not always been matched by corresponding development of teachers' knowledge and practical skills (Kaliisa & Picard, 2023; Thabologo & Keganneng, 2025).

In Kenya, government initiatives such as the Digital Literacy Programme, national ICT policies, the National Education Sector Strategic Plan, digital content developed through the Kenya Institute of Curriculum Development, and the Kenya Digital Superhighway have promoted technology-supported education (Republic of Kenya, 2019; Government of Kenya, 2023). The Competency-Based Curriculum further identifies digital literacy as a core competency and requires teachers to adopt learner-centred approaches that promote creativity, critical thinking, collaboration, communication, and problem-solving (KICD, 2017; Wangari & Okoth, 2022). Despite

these initiatives, studies indicate that many secondary school teachers possess mainly basic ICT skills and lack adequate technological pedagogical content knowledge for effective classroom integration (Mutua & Mwania, 2022; Mwangi, 2024). In mathematics, teachers have reported difficulties using graphing applications, simulations, interactive software, and other mathematics-specific digital resources (Oduor, 2024; Njoroge & Kamau, 2022). Mwangi (2024) reported that less than 40% of mathematics teachers regularly integrated digital learning tools into classroom instruction, while Wekesa and Nyabuto (2023) observed that many teachers mainly used technology for administrative rather than pedagogical purposes.

In Uasin Gishu County, secondary schools operate under different technological conditions, with some urban and peri-urban schools having relatively better access to computer laboratories, projectors, internet connectivity, online learning platforms, and digital content, while some rural schools continue to face limitations in electricity, connectivity, equipment, and technical support (Onyancha, 2024). Although access to digital technologies has increased, effective mathematics instruction still depends on whether teachers possess sufficient knowledge and practical skills to use these resources appropriately (Mwangi, 2024; Padilla-Escorcia et al., 2025). Existing studies in Kenya have largely focused on general ICT integration, infrastructure, teachers' attitudes, digital learning implementation, and Competency-Based Curriculum implementation, with limited emphasis on mathematics-specific digital technology knowledge and skills (Mugabe, 2023; Micheni et al., 2023; Boinett et al., 2025; Kiarie & Ondigi, 2025). Similarly, studies conducted in Uasin Gishu County have paid greater attention to general digital learning adoption and infrastructure challenges than to mathematics teachers' competence in selecting, operating, and pedagogically applying digital technologies (Onyancha, 2024). Therefore, this study sought to assess the level of digital technology knowledge and skills among mathematics teachers in secondary schools in Uasin Gishu County, Kenya.

2. Theoretical Framework

This study was grounded on the Technological Pedagogical Content Knowledge (TPACK) Framework developed by Mishra and Koehler (2006) and the Technology Acceptance Model (TAM) developed by Davis (1989). The two theories complement each other in explaining mathematics teachers' preparedness for integrating digital technologies into pedagogical practices. TPACK explains the knowledge and competencies teachers require to integrate technology effectively, while TAM explains how perceptions, attitudes, perceived usefulness, and perceived ease of use influence teachers' adoption of digital technologies. TPACK was developed as an extension of Shulman's (1986) Pedagogical Content Knowledge framework and proposes that effective technology-supported teaching requires the integration of Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK). Their interaction produces Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and ultimately Technological Pedagogical Content Knowledge (TPACK), representing the effective integration of technology, pedagogy, and subject content (Mishra & Koehler, 2006; Koehler et al., 2014).

The TPACK framework emphasizes that teachers require a balanced combination of technological, pedagogical, and content knowledge to create meaningful learning experiences. Technological Knowledge refers to teachers' understanding and ability to use and adapt to educational technologies, while Pedagogical Knowledge involves mastery of teaching approaches, classroom management, lesson planning, learner differences, and assessment practices (Kurt, 2019). Content Knowledge refers to

teachers' understanding and mastery of the specific subject matter they teach (Kultsum, 2017). Effective technology integration occurs when these three forms of knowledge are combined so that teachers can select technologies that are appropriate for particular content and pedagogical approaches rather than using technology independently of instructional goals (Mishra & Koehler, 2006; Koehler et al., 2014). Consequently, the framework demonstrates that access to digital devices alone is insufficient; teachers must understand how particular technologies can support specific content, learning activities, and instructional strategies.

The TPACK framework is particularly relevant to the present study because mathematics instruction requires specialized content knowledge, pedagogical approaches, and technological competencies for effective digital integration. Under the Competency-Based Curriculum, mathematics teachers are expected to use learner-centred and technology-supported approaches that promote conceptual understanding, creativity, collaboration, critical thinking, and problem-solving. Digital technologies such as graphing software, simulations, virtual manipulatives, online learning platforms, and educational applications can support mathematical visualization, exploration, and learner engagement when they are appropriately integrated into instruction (Niess, 2005; Pierce & Stacey, 2010). Recent studies further demonstrate that teachers with stronger TPACK competencies are more likely to integrate digital technologies effectively into their instructional practices and support improved learning outcomes (Schmid et al., 2021; Wang et al., 2024). Therefore, TPACK provides an appropriate theoretical basis for examining mathematics teachers' digital technology knowledge, pedagogical skills, and ability to integrate technology into mathematics teaching in secondary schools in Uasin Gishu County.

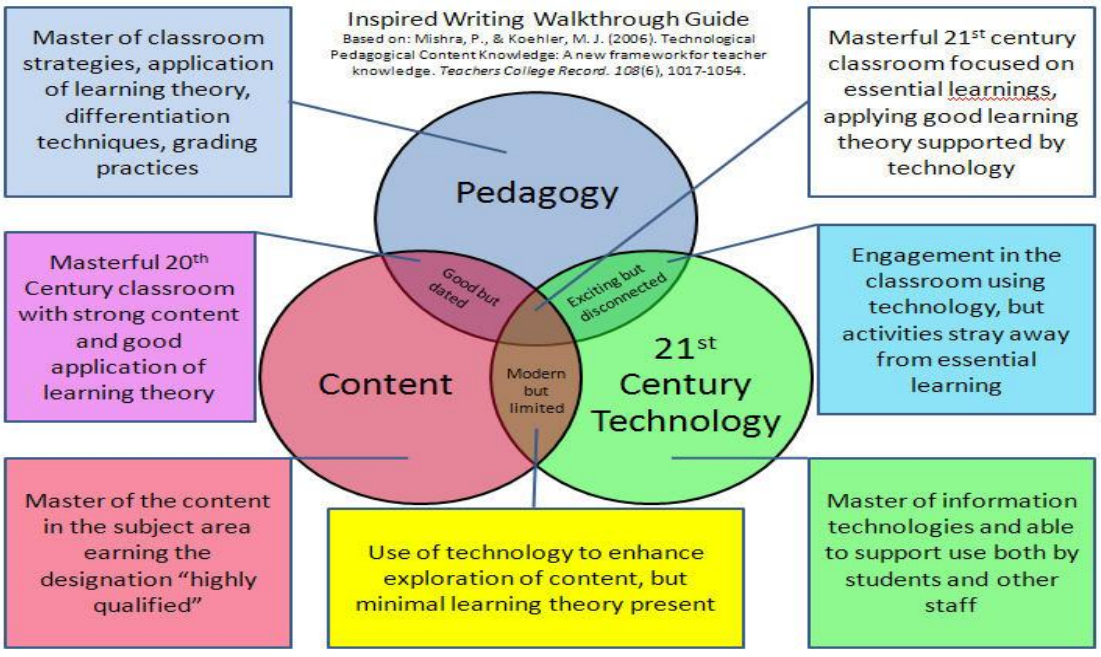


Figure 1: TPACK Model of Mathematics Instruction

Source: Mishra & Koehler (2006)

3. Review of Literature

The technological pedagogical content knowledge framework proposes that effective digital Digital technologies have increasingly transformed mathematics teaching and learning through tools such as graphing software, simulations, spreadsheets, dynamic geometry applications, virtual manipulatives, and learning management systems. However, the effectiveness of these technologies depends largely on teachers'

knowledge, competence, and ability to integrate them pedagogically rather than simply on the availability of technological devices (UNESCO, 2023; OECD, 2023). Teacher digital competence is therefore increasingly understood as a multidimensional construct involving technological knowledge, pedagogical integration, subject-specific application, assessment skills, reflective practice, and ethical use of emerging technologies such as artificial intelligence. Frameworks such as Technological Pedagogical Content Knowledge (TPACK), DigCompEdu, the UNESCO ICT Competency Framework for Teachers, AI-TPACK, Mathematical Digital Competency for Teaching, and Mathematics Pedagogical Competency emphasize that mathematics teachers require specialized digital competencies beyond general ICT skills because mathematics involves visualization, symbolic representation, modelling, conjecture testing, and multiple representations (Redecker, 2017; Dilling et al., 2024; Geraniou & Jankvist, 2024).

Global evidence indicates that mathematics teachers often demonstrate stronger basic technological knowledge than the more advanced pedagogical competencies required for meaningful classroom integration. Fabian et al. (2024), in a systematic review of 163 intervention studies, found that most teacher training programmes emphasized technological knowledge while giving inadequate attention to technological pedagogical content knowledge. Similarly, Padilla-Escorcia et al. (2025) reported relatively high self-perceived competence among in-service mathematics teachers in some dimensions of digital technology use, although they cautioned that self-reported competence may not reflect actual classroom practice. Vieira et al. (2023) also identified differences in digital competence among STEM teachers, while emerging AI studies show that technological pedagogical knowledge is becoming increasingly important for the ethical and effective integration of artificial intelligence in teaching (Celik, 2023; Tan et al., 2025). These studies suggest that effective digital competence requires not only technical knowledge but also the ability to connect technology with subject content and appropriate teaching strategies.

Evidence from Africa similarly shows that mathematics teachers' digital knowledge and skills remain moderate or low despite generally positive attitudes toward technology. In Tanzania, Njiku et al. (2022a) found moderate technology integration self-efficacy among mathematics teachers, with teachers who had completed computer literacy and technology integration courses demonstrating higher competence, while Rimba and Tarmo (2025) established that teachers' beliefs influenced ICT adoption in mathematics and science teaching. In Zambia, Mukuka and Alex (2025) reported low to moderate technological proficiency among mathematics teacher educators despite their strong willingness to use digital technologies. Likewise, Arhin et al. (2024) found that mathematics teachers in Ghana had positive perceptions of ICT but very low readiness in terms of familiarity with digital tools, access, confidence, and professional training, while Moila (2024) established that technology use among South African mathematics teachers remained largely teacher-centred. These findings demonstrate the need for continuous professional development that focuses not only on basic digital skills but also on mathematics-specific pedagogical integration.

In Kenya, government initiatives such as the Digital Literacy Programme, ICT in Education and Training Policy, and Competency-Based Curriculum have promoted digital literacy and technology-supported learning, yet mathematics teachers' digital knowledge and skills remain uneven. Murithi and Yoo (2021) found that many teachers had only basic computer literacy training and experienced difficulties integrating ICT because of inadequate facilities and limited competence, while national evidence cited in their study indicated that teacher training had lagged behind the provision of digital

devices. Mathematics-specific research by Mukenya et al. (2020) further showed that inadequate computers, limited ICT content preparation, and insufficient technological pedagogical training constrained ICT integration among secondary school mathematics teachers in Bungoma County. Nzoka (2022/2023) also reported positive relationships between teachers' ICT-related knowledge and students' mathematics performance. Overall, the literature shows that mathematics teachers generally possess stronger basic ICT skills than mathematics-specific digital pedagogical competence, that professional training significantly influences competence levels, and that positive attitudes do not automatically translate into effective integration where skills, infrastructure, and support are inadequate. The literature also reveals continued reliance on self-reported competence measures and limited attention to validated mathematics-specific and emerging AI-related competencies in African and Kenyan contexts, creating a gap that the current study seeks to address.

4. Methodology

The study adopted a pragmatist philosophy and a convergent parallel mixed methods design to examine the level of digital technology knowledge and skills among mathematics teachers in secondary schools in Uasin Gishu County, Kenya. Pragmatism supported the integration of quantitative and qualitative evidence, while the convergent parallel design allowed questionnaire and interview data to be collected concurrently, analyzed separately, and integrated during interpretation (Dube et al., 2024; Creswell & Creswell, 2021).

Sampling

The target population comprised mathematics teachers from 234 secondary schools distributed across the six sub-counties of Uasin Gishu County. Using the Krejcie and Morgan (1970) approach, 68 schools were selected. Four mathematics teachers were selected from each school, giving 272 mathematics teachers, while one principal or Head of Mathematics Department was purposively selected from each school as a key informant, giving 68 key informants and a total sample of 340 respondents. Proportionate stratified sampling was used to allocate the sampled schools across the six sub-counties, after which simple random sampling was used to select schools within each stratum. The resulting distribution comprised 19 schools in Soy, 12 in Turbo, 12 in Moiben, 9 in Ainabkoi, 12 in Kapseret, and 4 in Kesses (Saunders et al., 2023; Adeoye, 2023; Reddy, 2023).

Data Collection Instruments and Procedures

Quantitative data were collected from mathematics teachers using a structured questionnaire with five-point Likert-scale items, while qualitative data were obtained through semi-structured face-to-face interviews with principals and Heads of Mathematics Departments. The instruments were piloted in seven secondary schools in neighbouring Nandi County, involving 28 mathematics teachers, seven principals, and seven Heads of Mathematics Departments. The instruments were reviewed by supervisors and educational technology experts, while six experts assessed content validity. The construct measuring digital technology knowledge and skills among mathematics teachers contained 15 items and recorded a Content Validity Index of 0.923 and a Cronbach's alpha of 0.847, exceeding the recommended thresholds of 0.80 and 0.70, respectively (Polit & Beck, 2011; Hair et al., 2022). Qualitative credibility was strengthened through member checking, triangulation, field documentation, and comparison of interview findings with questionnaire results (Birt et al., 2016).

Data Analysis

Quantitative data were coded and analyzed using frequencies, percentages, means, and standard deviations to establish the level of digital technology knowledge and skills among mathematics teachers. Qualitative interview responses were transcribed, repeatedly read, coded, and organized into themes and sub-themes relating to digital technology knowledge and skills, institutional support, experiences, and challenges associated with digital technology integration (Clarke & Braun, 2022). Relevant verbatim quotations were used to support the qualitative findings. Consistent with the convergent parallel mixed methods design, quantitative and qualitative findings were compared and integrated during interpretation to identify convergence, complementarity, and divergence between statistical patterns and participants' experiences (Creswell & Creswell, 2023; Guetterman & Fetters, 2022).

5. Results and Discussion

The findings show that most respondents, 165 (68.2%), taught in public secondary schools, while 77 (31.8%) taught in private schools. Regarding school gender category, 95 (39.3%) were drawn from boys-only schools, 83 (34.3%) from girls-only schools, and 64 (26.4%) from co-educational schools. In terms of mathematics teaching experience, the largest proportion, 88 (36.4%), had taught for 5–10 years, followed by 69 (28.5%) with less than five years of experience, 46 (19.0%) with 11–15 years, and 39 (16.1%) with more than 15 years of experience. Overall, the respondents represented different school types, gender categories, and levels of teaching experience, providing diverse perspectives on mathematics teachers' preparedness for digital technology integration in secondary schools in Uasin Gishu County, Kenya

Table 1: Characteristics of the Mathematics Teachers and the Schools

Characteristic	Category	Frequency	Percent
School Type	Private	77	31.8
	Public	165	68.2
	Total	242	100
School Gender Category	Boys only	95	39.3
	Girls only	83	34.3
	Co-educational	64	26.4
	Total	242	100
Mathematics Teaching Experience	Less than 5 years	69	28.5
	5–10 years	88	36.4
	11–15 years	46	19
	Over 15 years	39	16.1
	Total	242	100

Training in Digital Technologies Integration in Mathematics Teaching and Learning

The study assessed whether mathematics teachers had received training related to digital technologies integration in teaching and learning because such training is important in developing the technological, pedagogical, and content knowledge required for effective classroom integration. The findings showed that 144 (60.0%) of

the respondents had not received any training related to digital technologies integration in mathematics teaching and learning, while 98 (40.0%) had received such training. This indicates that a substantial proportion of mathematics teachers in secondary schools in Uasin Gishu County lacked formal preparation in digital technologies integration. The findings suggest that many teachers may therefore depend on self-learning, peer support, or personal experience to develop digital competencies, which may limit their confidence and effectiveness in using digital tools for learner engagement, assessment, conceptual understanding, and mathematical problem-solving.

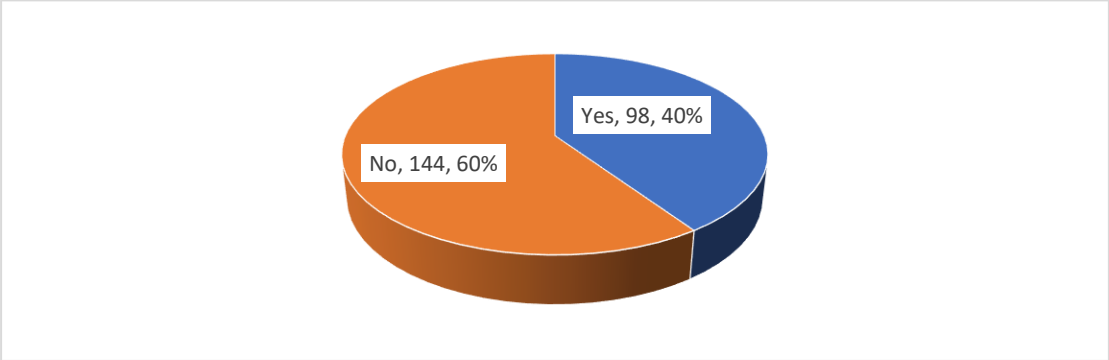


Figure 2: Training Related to Digital Technologies Integration in Teaching and Mathematics Learning

The quantitative findings were supported by the Key Informant Interviews with school principals and Heads of Mathematics Departments. One Head of Mathematics Department observed that,

> *"Many mathematics teachers are willing to use digital technologies, but only a few have undergone formal training specifically focused on integrating technology into mathematics instruction."*

Similarly, a school principal noted that,

> *"Most of the training opportunities available to teachers focus on general ICT skills rather than subject-specific applications for mathematics teaching. As a result, many teachers still lack confidence in using some digital tools effectively."*

These findings are consistent with Fabian et al. (2024), who found that many teacher training programmes emphasize technological knowledge while giving limited attention to Technological Pedagogical Content Knowledge. They also agree with Njiku et al. (2022a), who established that mathematics teachers who had undergone computer literacy and technology integration training demonstrated higher competence, and with Mukuka and Alex (2025) and Arhin et al. (2024), who reported low to moderate digital proficiency, limited confidence, and inadequate professional training among mathematics educators.

Within Kenya, the findings are consistent with Murithi and Yoo (2021), who reported that many teachers possessed only basic ICT literacy and experienced challenges integrating technology because of limited competence and inadequate training opportunities. Similarly, Mukenya et al. (2020) found that insufficient technological pedagogical training constrained ICT integration among secondary school mathematics teachers and recommended strengthening both pre-service and in-service training. Overall, the finding that six out of every ten mathematics teachers had not received relevant training points to a significant gap in teacher preparedness for digital technologies integration. This highlights the need for continuous professional development programmes focusing on mathematics-specific digital tools, pedagogical

integration strategies, and emerging technologies such as Artificial Intelligence in order to strengthen teachers' digital competence, confidence, and effective classroom application.

Type of Training Received on Digital Technologies Integration

Findings in Table 2 showed that among the respondents who had received training, the largest proportion, 28 (28.6%), attended Basic ICT and Computer Literacy Training, followed by 21 (21.4%) who had undergone CBC Digital Integration Training and 15 (15.3%) who had attended Google Classroom Training. A further 12 (12.2%) had been trained on Microsoft Office and Microsoft Teams, 8 (8.2%) on digital assessment tools such as Google Forms, Kahoot, and Quizizz, and 6 (6.1%) on online learning platforms such as Moodle, Zoom, and Google Meet. Only 5 (5.1%) had received training on mathematics-specific software such as GeoGebra and graphing applications, while just 3 (3.1%) had been trained on Artificial Intelligence tools such as ChatGPT, Gemini, and Microsoft Copilot. The findings indicate that most training opportunities focused on basic ICT literacy and general digital integration rather than specialized mathematics technologies and emerging digital tools.

Table 2: Types of Training Attended on Digital Technologies Integration in Mathematics Teaching and Learning

Type of Training Attended	Frequency	Percent (%)
Basic ICT and Computer Literacy Training	28	28.6
CBC Digital Integration Training	21	21.4
Google Classroom Training	15	15.3
Microsoft Office and Microsoft Teams Training	12	12.2
Digital Assessment Tools (Google Forms, Kahoot, Quizizz)	8	8.2
Online Learning Platforms (Moodle, Zoom, Google Meet)	6	6.1
Mathematics-Specific Software (GeoGebra, Graphing Applications)	5	5.1
Artificial Intelligence Tools (ChatGPT, Gemini, Copilot)	3	3.1
Total	**98**	**100**

The survey findings were supported by Key Informant Interviews with school principals and Heads of Mathematics Departments. One Head of Mathematics Department observed that,

> *"Most of our teachers have attended basic ICT courses and CBC-related digital training, but very few have been trained on Mathematics-specific software such as GeoGebra, graphing tools or other mathematics applications."*

Similarly, a school principal stated that,

> *"The training opportunities provided to teachers mainly focus on general computer skills and digital literacy. Specialized training in emerging technologies such as Artificial Intelligence and advanced mathematics applications is still very limited."*

Another Head of Mathematics Department noted that,

> *"Teachers are interested in using digital technologies in mathematics instruction, but many require additional training on how to integrate these tools effectively into lesson delivery and assessment."*

These findings reinforce the survey results by showing that although teachers have acquired foundational digital skills, significant gaps remain in mathematics-specific digital pedagogy and emerging technologies.The findings are consistent with Fabian et al. (2024), who reported that many teacher training programmes emphasize technological knowledge while giving inadequate attention to Technological Pedagogical Content Knowledge required for effective classroom integration. They also agree with Murithi and Yoo (2021), who found that many Kenyan teachers possessed only basic ICT literacy, and with Mukenya et al. (2020), who established that inadequate technological pedagogical training constrained ICT integration among secondary school mathematics teachers. The very low level of training in Artificial Intelligence tools further supports Celik (2023) and Tan et al. (2025), who noted that teacher preparedness for AI integration remains limited despite the rapid growth of AI in education. Similarly, Njiku et al. (2022a) found that teachers who had undertaken technology integration training demonstrated higher competence than those without such training. Overall, the findings suggest that mathematics teachers in Uasin Gishu County have mainly acquired general digital competencies, but more targeted professional development is needed in mathematics-specific software, digital assessment tools, online learning platforms, and Artificial Intelligence applications.

Frequency of Attendance of Digital Technology Professional Development Programmes

Findings in Table 3 showed that the majority, 137 (56.6%), of the respondents rarely attended digital technology-related professional development programmes, while 70 (28.9%) sometimes attended such programmes. A further 24 (9.9%) reported attending frequently, 9 (3.7%) very frequently, and only 2 (0.8%) had never attended. The findings indicate that participation in digital technology-related professional development among mathematics teachers was generally low, with more than half of the respondents rarely attending such programmes. This suggests that many teachers may have limited opportunities to update their knowledge and skills on emerging educational technologies, digital pedagogies, and technology-supported mathematics instruction.

Table 3: Frequency of Attendance of Digital Technology Professional Development Programmes

	Frequency	Percent
Never	2	0.8
Rarely	137	56.6
Sometimes	70	28.9
Frequently	24	9.9
Very frequently	9	3.7
Total	**242**	100

The survey findings were supported by Key Informant Interviews with school principals and Heads of Mathematics Departments, who indicated that professional development opportunities were often irregular and constrained by institutional factors. One Head of Mathematics Department observed that,

> *"Most teachers attend digital technology workshops only when they are organized by the Ministry of Education, TSC, or external partners. Such opportunities are not frequent enough to meet the changing technological demands in education" (KII#12, 2025).*

Similarly, a school principal noted that,

"Professional development programmes related to technology integration are often constrained by funding, time, and availability of trainers. As a result, only a few teachers are able to attend regularly" (KII#7, 2025).

Another Head of Mathematics Department remarked that,

"Technology is changing very fast, but many teachers do not receive continuous training. Some rely on self-learning or support from colleagues to keep up with new digital tools" (KII#23, 2025).

These findings show that although teachers recognize the importance of professional development, regular and sustained training opportunities remain inadequate. The findings are consistent with Njiku et al. (2022a), who found that teachers who participated in technology integration training demonstrated higher levels of technological competence and confidence than those with limited professional development exposure. They also support Fabian et al. (2024), who emphasized that continuous professional development is essential for strengthening teachers' Technological Pedagogical Content Knowledge and improving digital technology integration. Similar findings were reported by Mukuka and Alex (2025) and Arhin et al. (2024), who identified limited professional development opportunities as a major constraint to technological proficiency and ICT integration among mathematics educators in African contexts. Within Kenya, Murithi and Yoo (2021) similarly found that limited access to advanced and continuous digital training contributed to low levels of ICT competence among teachers. Overall, the findings highlight the need for more regular, structured, and mathematics-specific professional development programmes to strengthen teachers' digital competence, confidence, and effective integration of emerging technologies into mathematics instruction.

Level of Digital Technology Skills in Mathematics Instruction

Findings in Table 4 showed that the majority, 103 (42.6%), of the respondents rated their overall digital technology skills in mathematics instruction as low, while 64 (26.4%) rated their skills as moderate. A further 31 (12.8%) rated their skills as very high, 23 (9.5%) as very low, and 21 (8.7%) as high. Overall, more than half of the respondents, 126 (52.1%), rated their digital technology skills as low or very low, while only 52 (21.5%) rated their skills as high or very high. This indicates that many mathematics teachers in Uasin Gishu County perceived their digital competence to be below average, which may limit their ability to effectively integrate digital technologies into mathematics instruction.

Table 4: Level of Digital Technology Skills in Mathematics Instruction

	Frequency	Percent
Very low	23	9.5
Low	103	42.6
Moderate	64	26.4
High	21	8.7
Very high	31	12.8
Total	**242**	**100**

The survey findings were supported by Key Informant Interviews with school principals and Heads of Mathematics Departments. One Head of Mathematics Department stated that,

"Most teachers can perform basic computer operations such as preparing notes, searching for content online, and communicating digitally. However,

> *many struggle when it comes to using specialized Mathematics software and advanced instructional technologies" (KII#15, 2025).*

Similarly, a school principal noted that,

> *"The level of digital skills varies significantly among teachers. Some are highly competent and embrace new technologies, while others still require substantial support and training to use digital tools effectively in teaching" (KII#28, 2025).*

Another Head of Mathematics Department remarked that,

> *"Younger teachers tend to be more comfortable with digital technologies, but many teachers still lack confidence in integrating technology into lesson delivery, assessment, and learner engagement activities" (KII#9, 2025).*

These views reinforce the quantitative findings by showing that although basic digital literacy is common, advanced digital pedagogical skills remain limited. The findings are consistent with Murithi and Yoo (2021), who found that many Kenyan teachers possessed only basic ICT competencies and experienced difficulties integrating digital technologies into classroom instruction. They also agree with Arhin et al. (2024) and Mukuka and Alex (2025), who reported low to moderate levels of technological proficiency and confidence among mathematics educators despite positive attitudes toward technology use. Njiku et al. (2022a) further established that teachers who had undertaken computer literacy and technology integration training demonstrated higher competence levels than those without such training, while Fabian et al. (2024) observed that many teacher training programmes emphasize basic technological knowledge more than Technological Pedagogical Content Knowledge required for effective classroom integration. Overall, the findings highlight the need for targeted professional development in mathematics-specific digital technologies, digital assessment tools, advanced ICT applications, and emerging technologies such as Artificial Intelligence to strengthen teachers' digital competence and instructional effectiveness.

Specific Areas of Digital Technology Knowledge and Skills Among Mathematics Teachers

Findings in Table 5 indicated that mathematics teachers generally perceived themselves as having a high level of digital technology knowledge and skills, with a composite mean of 4.26 and a standard deviation of 0.64. The highest-rated areas included conducting virtual mathematics lessons through Zoom or Google Meet (M = 4.60), troubleshooting basic digital technology challenges (M = 4.55), confidently integrating digital technologies into mathematics pedagogy (M = 4.50), using digital assessment tools such as Kahoot, Quizizz, and Google Forms (M = 4.40), using Artificial Intelligence tools such as ChatGPT and Gemini (M = 4.36), and using GeoGebra and other mathematics software (M = 4.33). Respondents also reported regularly updating their digital skills (M = 4.28), possessing adequate knowledge of digital technologies in mathematics teaching (M = 4.22), and effectively using computers and laptops during lessons (M = 4.18). However, some response distributions revealed important concerns: 50.4% strongly disagreed and 35.1% disagreed that their teacher training had adequately prepared them for digital integration, 54.1% disagreed that they felt confident using digital technologies during mathematics instruction, 51.2% disagreed that they could use digital technologies to improve learner participation and engagement, and 48.8% disagreed that they possessed sufficient technical skills to integrate emerging technologies. These patterns suggest that although teachers generally reported strong digital competence, challenges remained in formal preparation, confidence, learner-centred integration, and use of emerging technologies.

Table 5: Specific Areas of Digital Technology Knowledge and Skills Among Mathematics Teachers

		SD	D	N	A	SA	Mean
I have adequate knowledge of using digital technologies in mathematics teaching.	%	2.5	1.2	9.9	44.2	42.1	4.22
I am able to use computers and laptops effectively during mathematics lessons.	%	3.3	2.5	7	47.1	40.1	4.18
I can integrate digital technologies into mathematics pedagogical practices confidently.	%	2.5	1.2	2.5	31.4	62.4	4.50
I am skilled in using online learning platforms such as Google Classroom and Moodle.	%	3.7	4.1	10.7	45.5	36	4.06
I can effectively use GeoGebra and other mathematics software in teaching.	%	2.1	1.7	40.9	49.2	6.2	4.33
I am able to use digital assessment tools such as Kahoot, Quizizz, and Google Forms.	%	2.1	1.2	5.8	36.4	54.5	4.40
I can use Artificial Intelligence tools such as ChatGPT and Gemini to support mathematics instruction.	%	2.1	1.2	7.9	36.8	52.1	4.36
I am able to conduct virtual mathematics lessons using Zoom or Google Meet.	%	2.1	0.8	2.1	25.2	69.8	4.60
I can troubleshoot basic digital technology challenges encountered during instruction.	%	1.7	1.7	25.2	67.4	4.1	4.55
I regularly update my digital technology skills for mathematics teaching.	%	2.5	1.2	9.1	40.5	46.7	4.28
My teacher training prepared me adequately for digital technologies integration in mathematics teaching.	%	50.4	35.1	9.5	2.1	2.9	4.14
I feel confident when using digital technologies during mathematics instruction.	%	2.1	54.1	30.2	2.1	11.6	4.08
I can guide learners in the effective use of digital technologies during mathematics lessons.	%	1.7	3.3	14.5	52.1	28.5	4.02
I can use digital technologies to improve learner participation and engagement in mathematics.	%	1.7	51.2	30.2	4.5	12.4	4.04
I possess sufficient technical skills to integrate emerging technologies into mathematics teaching.	%	12.8	48.8	33.5	1.7	3.3	4.09
Level of Digital Technology Knowledge and Skills Among Mathematics Teachers							4.26

The survey findings were supported by Key Informant Interviews with school principals and Heads of Mathematics Departments. One Head of Mathematics Department observed that,

> *"Most mathematics teachers can comfortably use computers, online platforms, and digital assessment tools. However, their ability to integrate these technologies effectively into pedagogy varies considerably" (KII#14, 2025).*

> *Similarly, a school principal noted that, "Teachers have become more technologically aware than before, especially after the COVID-19 period. However, some still require support in applying technology to improve learner engagement and higher-order mathematical thinking" (KII#27, 2025).*

Another Head of Mathematics Department remarked that,

> *"Many teachers can use digital tools, but fewer are confident in advanced technologies such as AI applications, simulations, and specialized mathematics software. Continuous training is therefore necessary" (KII#33, 2025).*

These views confirm that while basic and intermediate digital competencies are relatively well developed, advanced technological and pedagogical skills remain uneven among mathematics teachers. The findings are consistent with Padilla-Escorcia et al. (2025), who reported relatively high self-perceived digital competence among mathematics teachers, and with Vieira et al. (2023), who found that STEM teachers generally possessed adequate digital skills although competence varied across technology domains. They also support Celik (2023) and Tan et al. (2025), who demonstrated that technological pedagogical knowledge and AI competence strengthen teachers' ability to integrate emerging technologies effectively. Njiku et al. (2022a) similarly found that teachers who had undergone technology integration training demonstrated higher levels of self-efficacy and digital competence. However, the gaps in confidence, pedagogical integration, and formal preparation are consistent with Fabian et al. (2024), who argued that many teacher-training programmes emphasize technological skills more than Technological Pedagogical Content Knowledge, and with Mukenya et al. (2020), who identified inadequate technological pedagogical preparation as a major barrier among secondary school mathematics teachers in Kenya. Overall, the findings indicate that mathematics teachers in Uasin Gishu County possess relatively high self-perceived digital knowledge and skills, but continued support is needed in advanced technologies, mathematics-specific applications, and learner-centred pedagogical integra

6. Conclusion

The findings indicate that mathematics teachers in secondary schools in Uasin Gishu County still face notable gaps in digital technology preparation and continuous professional development. Many teachers had not received formal training specifically focused on integrating digital technologies into mathematics teaching, while participation in digital technology-related professional development was generally infrequent. Where training had been provided, it mainly focused on basic ICT literacy, CBC-related digital integration, and general applications, with limited emphasis on mathematics-specific software and emerging technologies such as Artificial Intelligence. This suggests that teachers' digital preparation remains stronger in general ICT use than in specialized mathematics-focused digital pedagogy.

At the same time, teachers reported confidence in some specific areas, including virtual lesson delivery, digital assessment tools, computers and laptops, online platforms, and selected Artificial Intelligence applications. Key informants similarly observed that many teachers were able to perform basic digital tasks but experienced greater difficulty when using specialized mathematics software, simulations, advanced digital applications, and technology for learner-centred instruction. The findings therefore suggest that while basic digital literacy is developing, advanced technological-pedagogical competence remains uneven. This highlights the need to distinguish between being able to use digital tools and being able to integrate them effectively into mathematics content, assessment, learner engagement, and higher-order problem-solving.

However, the item-level findings should be interpreted with caution because some of the reported means do not appear to correspond with the displayed response distributions in Table 5. This inconsistency makes it difficult to make a firm conclusion about the overall level of digital technology knowledge and skills. Nonetheless, the evidence consistently points to gaps in formal training, continuous professional development, mathematics-specific digital competence, and preparedness for emerging technologies.

7. Recommendations

The Teachers Service Commission, Ministry of Education, Kenya Institute of Curriculum Development, school administrators, and other education stakeholders should strengthen continuous professional development for mathematics teachers by placing greater emphasis on mathematics-specific digital pedagogy. Training should focus on practical use of GeoGebra, graphing applications, simulations, digital assessment tools, online learning platforms, and responsible use of Artificial Intelligence in mathematics teaching.

Professional development should be regular and sustained rather than limited to occasional workshops. Schools should also support peer mentoring, collaborative lesson preparation, professional learning communities, and technical assistance so that teachers can practise and apply newly acquired digital skills in real classroom settings. Greater attention should be given to how digital technologies can support lesson delivery, learner participation, assessment, feedback, visualization, and mathematical problem-solving.

Before publication, the original questionnaire data should also be reviewed to confirm the accuracy of the item means and the overall composite score for digital technology knowledge and skills. Resolving the inconsistencies between the response distributions and reported means would strengthen the credibility of the conclusions while retaining the clear evidence that teachers require more structured, regular, and subject-specific digital professional development.

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