

Characteristics of mobile smartphone applications for teacher professional development: an A2IT2 model perspective

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Abstract. This study explored the potential of mobile smartphone applications to improve teacher professional development (TPD) in rural Tanzanian primary schools, using the A2IT2 model as a guiding framework. A mixed-methods approach was adopted, involving 130 teachers and key educational stakeholders, to examine teachers' demographic characteristics, mobile phone usage, pre-intervention knowledge, skills, attitudes, and perceptions of mobile applications. The findings showed that although most teachers regularly use mobile phones, engagement with educational applications remains limited, emphasising the need for targeted training and awareness. Pre-intervention assessments indicated low levels of knowledge and skills but moderately positive attitudes, with attitudes identified as the strongest predictor of perceptions. Teachers highlighted the importance of accessibility, content relevance, interactivity, collaboration, usability, and bilingual support for effective adoption. Stakeholder insights reinforced the necessity for context-sensitive, locally relevant design. The study concludes that mobile applications that incorporate pedagogically aligned content, interactive features, and user-centred design, and are supported by technical and attitudinal interventions, can enhance teacher engagement, professional growth, and classroom practice in resource-constrained settings.

Keywords: teacher professional development, mobile applications, A2IT2 model, mobile learning

1. Introduction

Teacher professional development (TPD) is an ongoing process that equips educators with the skills, knowledge, and strategies necessary to enhance classroom practice and learning outcomes. Recently, mobile applications have emerged as an innovative and accessible means of supporting teachers' professional growth. Their flexibility, cost-effectiveness, and potential for personalised learning make them particularly suitable for settings where teachers face resource limitations and limited access to traditional professional development opportunities [16, 28].

Traditionally, professional learning has been conducted through formal, top-down programs where policymakers create training content for large groups of teachers [36]. While this method efficiently reaches many educators simultaneously, it often fails to address individual learning needs and can cause disengagement [34]. Conversely, informal professional development allows teachers to focus on areas relevant to their personal interests and classroom challenges [30]. This learner-centred approach aligns with the Align-Attain-Integrate-Teach-Train (A2IT2) model, which emphasises leveraging existing resources, especially mobile technology, to improve teaching practices. By encouraging innovative, technology-driven solutions, the A2IT2 model demonstrates how smartphones can make professional learning more personalised and sustainable [28].

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Globally, mobile apps are increasingly used in teacher professional development with encouraging outcomes. For instance, in Bangladesh, mobile technology kits have been expanded to train over 67,000 teachers, providing access to resources and facilitating ongoing collaboration among educators [6]. Similarly, in Sri Lanka, workshops have been held to help teachers see the educational value of mobile phones, integrate them into science lessons, and share app-based techniques with colleagues [19]. These examples demonstrate how mobile applications can promote favourable attitudes toward technology in education and support subject-specific professional growth.

In South Africa, challenges such as limited device access, high internet costs, and perceived ineffectiveness hinder adoption [9]. However, research indicates that the most substantial gains from educational technology are achieved when mobile applications are used alongside teacher guidance, contextual feedback, and peer collaboration [23]. Teachers commonly use smartphones to watch instructional videos, observe model lessons, and reflect on their own teaching. Furthermore, many engage in online communities of practice through social media and internet-based platforms, enabling them to share lesson ideas, develop content, and adapt digital resources to suit their local contexts [4].

Several barriers continue to hinder the effective use of mobile smartphone applications in Tanzania. Poor internet connectivity affects more than 80% of teachers, while high data costs limit frequent engagement with online platforms [18, 27]. Moreover, the lack of structured training is a significant obstacle, with 88% of teachers reporting they had not received any instruction on using mobile apps for professional development [16, 22]. Despite these challenges, teachers were willing to adopt mobile technology if provided with adequate training, peer support, and reliable infrastructure.

The widespread ownership of smartphones among Tanzanian teachers presents an important opportunity. Although many educators own smartphones and even government-issued tablets, these devices are underused for professional learning [25, 26]. The National Framework for Teachers' Continuous Professional Development (NF-TCPD), introduced in 2020, encourages digital integration but does not explicitly recognise mobile phones as tools for CPD. This omission reflects a missed opportunity to harness accessible mobile technology for professional growth, particularly in rural and underserved areas [7].

To address these gaps, the proposed A2IT2 model offers a context-responsive framework for integrating mobile applications into teacher professional development. The model focuses on aligning mobile learning with teachers' needs, acquiring relevant digital competencies, integrating resources into daily practice, facilitating collaborative teaching through peer support, and providing structured training. By doing so, it seeks to transform smartphones from underutilised devices into powerful tools for continuous, flexible, and personalised professional growth [28].

1.1. Research questions

- Q1. Which features of A2IT2-aligned mobile apps, such as accessibility, content quality, interactivity, and usability, support teacher professional development?
- Q2. How do teacher factors like digital skills, attitudes toward technology, and demographics affect the effectiveness and use of A2IT2 apps for professional development?

2. Theoretical framework

Davis [12] developed the technology acceptance model (TAM), which comprises various components that represent the user acceptance process of Information and Communication Technology. This process includes behavioural intention, perceived usefulness, and perceived ease of use. While perceived usefulness refers to the extent to which an individual believes in the benefits of using a specific technology, perceived ease of use pertains to the importance of technology being user-friendly [24].

The theory describes technology adoption as a process that unfolds in three stages. Initially, external variables, such as system design features, influence users' cognitive evaluations, specifically their perceptions of how easy the technology is to use and how useful it will be. These perceptions then shape an adequate response, such as a user's attitude toward using the technology or their intention to use it, which ultimately leads to actual usage behaviour [12, 13]. According to TAM, this behaviour is primarily driven by perceived usefulness, perceived ease of use, and the intention to use the technology.

Perceived usefulness refers to the belief that using a system will enhance performance, while perceived ease of use relates to the notion that engaging with the system will not be effortful [13]. A subsequent study suggested that behavioural intention could be replaced by attitude toward the behaviour, which represents an emotional evaluation of the potential outcomes [1]. The stronger the affective reaction, the more likely the user is to engage in the behaviour. Notably, perceived usefulness can directly influence actual usage, underscoring its central role in technology adoption. Although perceived ease of use does not directly predict behaviour, it significantly influences perceived usefulness, thereby affecting user acceptance indirectly [13].

This model has made significant theoretical and practical contributions, particularly by offering validated constructs that correlate strongly with user behaviour. These constructs have enabled researchers to evaluate the cognitive and emotional processes that mediate the effects of system features on technology adoption. TAM has also proven effective in assessing user motivation across a wide range of information systems — a goal that was difficult to achieve before reliable subjective measurement tools became available [5].

The TAM was a valuable guide for designing, implementing, and evaluating mobile-based professional development programs for teachers. At the design stage, TAM informed developers to prioritise features that were easy to use and directly beneficial to teaching practices. For example, educational mobile applications were selected based on teachers' preferences. During the implementation stage, training and onboarding focused on demonstrating the application's practical value, joining peer learning communities, and participating in short professional development modules. These efforts positively influenced teachers' perceptions of the app's usefulness. Regular technical support and feedback mechanisms were provided to enhance perceived ease of use, helping teachers feel confident using the technology without requiring extensive ICT skills. In the monitoring and evaluation stage, TAM was used to assess the intervention's success by examining behavioural intentions and actual usage patterns, which reflected teachers' levels of technology acceptance. Insights gathered informed improvements to both the application's design and the professional development approach.

3. Methods

3.1. Research design

This study employed a design-based research methodology to develop and refine mobile-based professional development interventions for rural primary school teachers. Guided by Plomp and Nieveen [33] and grounded in the A2IT2 model, the design emphasised collaboration between researchers and teachers. Through repeated cycles of design, testing, and refinement, the study aimed to produce effective, contextually relevant, and practical training materials for resource-limited rural schools.

The A2IT2 training prototype was designed to align with Tanzania's national education standards and address the unique challenges faced by rural schools. The modules prioritised contextual relevance, scalability, and compliance with the Ministry of Education, Science, and Technology's policies. Key considerations included curriculum-aligned, user-friendly mobile applications; support for offline and flexible learning; efficient training sessions; peer collaboration via platforms such as WhatsApp; and detailed user manuals to ensure sustainability. These features ensured that the intervention was both feasible and adaptable to rural settings.

The design process operationalised the A2IT2 model through five phases. The first phase, Align,

involved baseline assessments of teachers' digital literacy, familiarity with educational applications, and professional development needs. The second phase, Attain, facilitated co-development of principles and guidelines by teachers, fostering ownership and relevance to their context. The third phase, Integrate, tested the model's practicality through structured training, peer practice, and school-based micro-pilots, with ongoing feedback guiding improvements. The fourth phase, Teach, enhanced teachers' hands-on skills by enabling them to use mobile applications in simulated lessons and peer-teaching, thereby boosting confidence and mastery of digital tools.

The final phase, Train, used a train-the-trainer approach, with selected teachers and school leaders cascading the A2IT2 training to colleagues within their schools. Pre- and post-assessments measured changes in digital literacy, confidence, and collaboration practices. This structured, iterative process ensured that the A2IT2 model was not only theoretically robust but also practical and scalable for ongoing professional development among rural teachers.

3.2. Participants

One hundred and thirty (130) participants were involved in this study. They were purposively selected from fifteen (15) primary schools within the Arusha District Council, with permission from the District Primary Education Officer (DPEO) and the respective school authorities. The selected schools were Naurei, J.K. Nyerere, Sekei, Ilboru, Kisongo, Mateves, Natema, Ngaramtoni, Olgilai, Enaboishu, Moivo, Loruvani, Olomitu, Nduruma, and Mlangarini. Schools unable to participate were excluded because of other national commitments, such as supervising the 2024 local government elections and organising national sports competitions.

A total of one hundred and twenty (120) teachers, including school heads, participated in the study. All teachers owned smartphones and willingly joined the A2IT2 training model, demonstrating readiness and interest in mobile-based professional development. To implement the peer-led training approach, school heads nominated volunteers, resulting in eleven (11) peer trainers whom the researchers and an IT expert prepared to cascade training within their schools.

In addition, ten (10) educational stakeholders participated. These included one (1) Regional Education Officer (REO), one (1) Zonal School Quality Assurance Officer (ZSQA), three (3) District School Quality Assurance Officers (DSQAOs), three (3) Ward Education Officers (WEOs), one (1) District Primary Education Officer (DPEO), and one (1) IT expert from the Institute of Accountancy Arusha (IAA). Their involvement provided technical expertise, supervision, and policy-level support, ensuring that the intervention aligned with national education priorities.

3.3. Research instruments and measures

The study employed questionnaires, interviews, focus group discussions (FGDs), peer teaching observations, and achievement tests to collect data. A structured questionnaire was administered to 120 teachers before the intervention, with sections covering demographic details, professional development activities, and self-reported competence in mobile smartphone use. Most items were rated on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree), which was effective for capturing teachers' attitudes and skills measurably [3].

Semi-structured interviews were conducted with education stakeholders, including the REO, ZSQA, DSQAOs, WEOs, and the DPEO, to explore contextual challenges and policy considerations in mobile-based professional development. With consent, interviews were audio-recorded, transcribed, and thematically analysed [29]. FGDs were held with groups of 6–8 teachers and peer trainers after training sessions, enabling participants to reflect on shared experiences and debate the practicality of the A2IT2 model [32].

Peer teaching observations were conducted at Naurei TRC and in individual schools, using structured checklists and field notes to document how teachers used mobile applications during training. Achievement tests were administered before and after the intervention to assess knowledge and skill

acquisition, with items covering basic mobile features, practical digital skills, and classroom applications of mobile tools. Comparing pre- and post-test results provided evidence of the intervention's effectiveness in strengthening teachers' competencies [37].

3.4. Validity and reliability

This study employed both quantitative and qualitative quality criteria to ensure methodological rigour. Content validity was established through expert review of questionnaires, interview guides, observation checklists, FGDs, and achievement tests by supervisors and peers from the University of Dodoma. Their feedback was incorporated to refine clarity, coverage, and alignment with the A2IT2 intervention objectives. Instruments were also piloted in two non-sample schools to confirm contextual relevance.

Reliability was assessed through pilot testing, test-retest procedures, and statistical analysis using Cronbach's alpha; all domains exceeded the recommended 0.70 threshold. Internal consistency was further supported by inter-rater reliability, achieved through observers' training and scoring harmonisation. Data triangulation across questionnaires, interviews, FGDs, observations, and field notes enhanced both credibility and confirmability of findings. To ensure transferability, the study provided detailed descriptions of context, participants, and procedures, while prolonged field engagement and collaborative development of the A2IT2 resources strengthened credibility. Dependability was assured through peer debriefing, external audits, and systematic documentation of methodological decisions. Finally, all instruments were translated into Kiswahili and back-translated into English to maintain cultural validity and conceptual accuracy.

3.5. Data analysis procedure

This study employed a mixed-methods approach within a Design-Based Research (DBR) framework, aligned with the A2IT2 model phases (Align, Attain, Integrate, Teach, Train). Quantitative data from teacher questionnaires and pre-intervention knowledge, skills, and attitudes assessments were analysed using IBM SPSS Statistics version 27. Descriptive statistics (means, standard deviations, frequencies, and percentages) summarised teachers' demographics, mobile phone usage, and perceptions of mobile applications. Inferential analyses, including multiple regression, examined the predictive relationships between pre-intervention knowledge, skills, attitudes, and teachers' perceptions, providing evidence of factors influencing readiness to adopt mobile-based professional development.

Qualitative data from interviews with teachers and key educational stakeholders were analysed following Yin's analytic logic, using transcription, immersion, and a combined deductive-inductive coding strategy. Codes were organised in a codebook and subjected to pattern matching and explanation-building to relate the findings to the A2IT2 model propositions. Themes and subthemes covering Accessibility and Compatibility, Content and Relevance, Interactivity and Collaboration, and Usability and Language were displayed in matrices to enable cross-case comparisons.

4. Results and discussion

4.1. Demographic characteristics and mobile phone awareness of respondents

The demographic profile of the 130 respondents was analysed by examining key variables, including sex, education level, year of qualification, and age group. This analysis provided a clearer understanding of the composition of rural primary school teachers participating in the study. It offered insights into how these characteristics might influence their engagement with professional development through mobile smartphone applications.

Of the respondents, 70 were male (53.8%), and 60 were female (46.2%). This fairly balanced gender distribution suggests that both male and female teachers were well represented, promoting

inclusivity in the professional development programme.

Teachers' highest qualifications varied, with Diploma holders forming the largest group (46; 35.4%), followed by Degree holders (37; 28.5%), Certificate holders (18; 13.8%), and a small number of Master's degree holders (5; 3.8%). Age-specific analysis revealed that younger teachers (25–35 years) mostly hold Certificates and Diplomas, reflecting early career stages. In contrast, older teachers (41–50 years) predominantly hold Diplomas and Degrees, with a few holding Master's degrees, indicating steady professional growth over time.

Regarding the year of qualification, the largest groups were those trained between 2011–2015 (54, 41.5%) and 2016–2020 (37, 28.5%), while teachers who qualified between 2000–2010 (39, 30%) formed the more experienced cohort. This mix of newly trained and experienced teachers suggests that professional development initiatives should carefully balance younger teachers, who may be more technologically adept, with older teachers, who may need additional support to adapt to mobile-based learning.

The age distribution further showed that the 31–35-year group (37, 28.5%) and the 36–40-year group (29, 22.3%) were the most represented, reflecting a relatively young and active teaching workforce. Teachers aged 46 and older (24, 18.5%) were the least represented. These findings suggest that younger teachers may adapt more quickly to technology-supported professional development initiatives, such as the A2IT2 model, while older teachers may benefit from mentorship and gradual integration strategies.

The study also examined teachers' mobile phone use and their awareness of educational applications, both of which are critical to adopting mobile-based professional development. Most respondents reported regular use: 91 teachers (75.8%) used their phones several times a week, and 16 teachers (13.3%) used them daily. Occasional and rare users were fewer, with 10 (8.3%) and 3 (2.5%) respondents, respectively. This suggests that mobile phones are generally accessible, though daily engagement remains limited, likely due to factors such as internet connectivity, electricity supply, or data costs.

Teachers' willingness to use mobile phones for learning varied. While 45 respondents (37.5%) reported being likely or very likely to use mobile phones to enhance their knowledge, 63 teachers (52.5%) were unlikely or very unlikely to do so, and 12 (10.0%) were neutral. This highlights both opportunities and challenges: some teachers recognise the potential of mobile technology for professional development, whereas others remain hesitant, possibly due to limited exposure to educational apps or gaps in digital skills.

When asked about the main purpose of owning a mobile phone, the largest share of teachers reported using them for social interaction (44, 36.7%) and for communication via calls, texts, or emails (39, 32.5%). Internet browsing was reported by 22 respondents (18.3%), while far fewer reported using mobile phones for educational apps (10, 8.3%) or entertainment (5, 4.2%). These findings suggest that although mobile phones are widespread among teachers, they are primarily used for social and personal purposes rather than for professional development. This underscores the need for targeted awareness campaigns and training to demonstrate how mobile applications can effectively support teachers' professional development.

The characteristics of mobile smartphone applications align with the A2IT2 model of teacher professional development.

Before implementing the A2IT2 model, it was essential to establish a baseline of teachers' knowledge, skills, and attitudes (KSAs) related to using mobile smartphone applications for professional development (table 1). This pre-intervention assessment served two purposes: first, to highlight teachers' existing abilities and limitations in digital engagement, and second, to provide a diagnostic foundation for tailoring the intervention to the local context. Pre-intervention assessments are particularly important in educational research because they reveal participants' readiness and prior experiences, which can significantly influence the adoption of new teaching practices [10].

In rural Tanzanian contexts, disparities in technological infrastructure, digital literacy, and pedagogical support often persist, underscoring the need to understand teachers' pre-existing conditions. Teachers' knowledge reflects familiarity with smartphone functions and digital learning resources;

Table 1

Pre-intervention knowledge, skills, and attitudes.

Section	Item	Strongly disagree (n, %)	Disagree (n, %)	Neutral (n, %)	Agree (n, %)	Strongly agree (n, %)	<i>M ± SD</i>
Knowledge	I am aware of mobile applications for teacher professional development	40 (33.3)	50 (41.7)	15 (12.5)	10 (8.3)	5 (4.2)	1.97 ± 1.02
	I know how mobile applications can be used to improve teaching	42 (35.0)	48 (40.0)	15 (12.5)	10 (8.3)	5 (4.2)	1.95 ± 1.03
	I am familiar with at least one educational app for teachers	45 (37.5)	50 (41.7)	15 (12.5)	7 (5.8)	3 (2.5)	1.87 ± 1.01
	I understand how to access multimedia content through apps	40 (33.3)	48 (40.0)	15 (12.5)	10 (8.3)	7 (5.8)	1.98 ± 1.05
Skills	I can download and install mobile applications without assistance	38 (31.7)	50 (41.7)	15 (12.5)	10 (8.3)	7 (5.8)	1.97 ± 1.03
	I can search for teaching materials via apps	40 (33.3)	48 (40.0)	15 (12.5)	10 (8.3)	7 (5.8)	1.98 ± 1.04
	I can use interactive features in apps	42 (35.0)	50 (41.7)	15 (12.5)	8 (6.7)	5 (4.2)	1.93 ± 1.03
	I am confident in troubleshooting basic app problems	45 (37.5)	50 (41.7)	15 (12.5)	7 (5.8)	3 (2.5)	1.87 ± 1.01
Attitudes	I believe mobile applications are useful for professional development	40 (33.3)	45 (37.5)	20 (16.7)	10 (8.3)	5 (4.2)	1.94 ± 1.05
	I am willing to use mobile applications regularly	42 (35.0)	48 (40.0)	15 (12.5)	10 (8.3)	5 (4.2)	1.95 ± 1.04
	I would recommend that other teachers use mobile applications	45 (37.5)	48 (40.0)	15 (12.5)	8 (6.7)	4 (3.3)	1.91 ± 1.03
	I think data cost or poor internet limits mobile app use	25 (20.8)	35 (29.2)	25 (20.8)	20 (16.7)	15 (12.5)	2.47 ± 1.34

skills indicate their ability to integrate these tools into professional practice; and attitudes capture their motivation, openness, and disposition toward adopting mobile applications for professional growth. Collectively, these three dimensions provide a comprehensive picture of teachers' starting points, informing the alignment phase of the A2IT2 model.

Based on the table 1, teachers' mean scores for knowledge and skills were low (≈ 1.87 to 1.98), indicating limited familiarity with and use of mobile apps for development. Attitude scores were slightly higher but still moderate (≈ 1.91 to 1.95), reflecting openness tempered by experience. The item on data costs/internet had the highest mean (2.47 ± 1.34), signalling infrastructural constraints as a key barrier. Overall, the findings place participants in an early stage of technology adoption.

4.2. Teachers' perceptions of mobile smartphone applications

Teachers' perceptions of mobile applications were assessed across four themes: accessibility and compatibility, content and relevance, interactivity and collaboration, and usability and language (table 2).

Table 2

Teachers' perceptions of mobile smartphone applications.

Item	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	<i>M ± SD</i>
<i>Accessibility and compatibility</i>						
Apps should be compatible with multiple devices/platforms	2	4	8	50	56	4.28 ± 0.89
Apps should be small for easy installation	3	5	10	52	50	4.20 ± 0.91
Cost of apps should be affordable/free	2	4	12	53	49	4.20 ± 0.87
High internet cost discourages app use	38	32	25	15	10	2.39 ± 1.23
<i>Content and relevance</i>						
App content should be relevant to teaching needs	2	5	10	55	48	4.18 ± 0.88
Apps should provide multimedia content	3	6	12	54	45	4.10 ± 0.93
Apps should offer up-to-date and reliable information	2	5	10	56	47	4.20 ± 0.87
Apps can improve knowledge and teaching practices	3	4	8	55	50	4.23 ± 0.86
<i>Interactivity and collaboration</i>						
Apps should have interactive features	3	5	12	53	47	4.13 ± 0.91
Apps should offer collaborative features	3	6	15	50	46	4.10 ± 0.94
Apps should allow teachers to share experiences	4	8	14	52	42	3.99 ± 0.97
I am willing to collaborate with other teachers via apps	3	6	12	55	48	4.17 ± 0.90
<i>Usability and language</i>						
Apps should be simple to use	2	4	10	55	49	4.21 ± 0.87
Apps should be available in English and Kiswahili	3	5	12	53	47	4.14 ± 0.91
Apps should work effectively online and offline	2	4	10	55	49	4.21 ± 0.87
If trained, I am confident in using apps effectively	2	4	8	56	50	4.25 ± 0.85

Teachers' perceptions were generally positive, with mean scores ranging from 3.99 to 4.28. High ratings were reported for accessibility, content relevance, usability, and confidence in app use when trained. Concerns about internet costs highlight structural barriers, but overall, teachers recognise the potential of mobile apps for professional development.

Additionally, the study gathered insights from key educational stakeholders, including the Regional Education Officer (REO), Ward Education Officer (WEO), District Primary Education Officer (DPEO), District School Quality Assurance Officer (DSQAO), and Zonal School Quality Assurance Officer (ZSQAQO), on the essential features of mobile applications for teachers' professional development (table 3). A standardised set of guiding questions was posed to all participants to ensure consistent and comparable responses. To respect their professional commitments, each interview was conducted individually at a time convenient for the participant, promoting openness and reducing scheduling bias. The responses were then analysed collectively, which not only facilitated thematic convergence across administrative levels but also enhanced the credibility of the findings through triangulation of perspectives.

Table 3

Stakeholder perspectives on essential features of mobile applications.

Theme	Response counts	Representative quote
Accessibility and compatibility	9/10	“Most of us prefer mobile applications that work smoothly across devices and do not consume too much data. If an app requires constant internet access or is resource-intensive, it becomes difficult for rural teachers like us to rely on it.”
Content and relevance	9/10	“For professional development, the content must directly connect to what we teach in class. Applications with locally relevant examples aligned with the curriculum are far more valuable than those offering general or foreign content.”
Interactivity and collaboration	9/10	“The best part of mobile applications is that they let us interact, ask questions, and share ideas with other teachers. Collaboration through chat groups or forums makes learning practical and motivates us to keep using the app.”
Usability and language	10/10	“Even the most advanced app will not help us if it is difficult to navigate or available only in English. Teachers appreciate simple designs and local-language options because they make the learning process more inclusive and less intimidating.”

4.3. Multiple regression analysis

A multiple regression analysis was conducted to determine the extent to which pre-intervention knowledge, skills, and attitudes predicted teachers’ perceptions of mobile smartphone applications (table 4).

Table 4

Model summary.

Model	R	R ²	Adjusted R ²	Std. Error
1	0.78	0.61	0.60	0.48

The model is statistically significant ($F(3, 116) = 63.56, p < 0.001$), explaining 61% of the variance in perceptions (table 5).

Table 5

ANOVA for regression model.

Source	SS	df	MS	F	Sig.
Regression	69.42	3	23.14	63.56	< 0.001
Residual	44.82	116	0.39	—	—
Total	114.24	119	—	—	—

Attitudes are the strongest predictor ($\beta = 0.34, p < 0.001$), followed by Knowledge ($\beta = 0.28$) and Skills ($\beta = 0.24$). This implies that while capability is important, mindset and openness exert a larger influence on perception (table 6).

Regression equation:

$$\text{Perceptions} = 0.52 + 0.32 \times (\text{Knowledge}) + 0.28 \times (\text{Skills}) + 0.39 \times (\text{Attitudes})$$

The model accounted for ~61% of the variance in teachers’ perceptions (Adjusted $R^2 = 0.60$). Therefore, teachers’ pre-intervention knowledge, skills, and attitudes significantly predicted their

Table 6

Regression coefficients.

Predictor	B	Std. Error	β	t	Sig.
(Constant)	0.52	0.27	—	1.93	0.056
Knowledge	0.32	0.10	0.28	3.20	0.002
Skills	0.28	0.10	0.24	2.80	0.006
Attitudes	0.39	0.10	0.34	3.90	< 0.001

perceptions of mobile smartphone applications. While knowledge and skills were limited, attitudes were relatively more positive, highlighting the importance of fostering supportive mindsets alongside technical capacity. These findings provide a strong rationale for the A2IT2 intervention, ensuring it addresses both digital competence and attitudinal readiness for effective professional development.

5. Discussion

5.1. Demographic characteristics

The demographic composition of the 130 primary school teachers in this study provides crucial insight into how mobile-phone-based professional development (PD) interventions such as A2IT2 might be received and which strategies might maximise uptake and impact.

In the sample, the gender mix was fairly balanced (53.8% male, 46.2% female). This near parity is advantageous for ensuring that findings on mobile PD adoption are not unduly gender-biased and that both male and female teachers' experiences are represented. Literature on technology adoption among teachers suggests that gender sometimes correlates with differences in self-efficacy and attitudes toward technology. For example, in some LMIC contexts, female teachers have reported lower confidence in adopting new digital tools, though not always lower performance, especially when given adequate training. While the balanced sample does not guarantee equal readiness, it does make it feasible to investigate whether gendered patterns of digital literacy or attitude exist in this environment.

Regarding formal qualifications, a majority held Diplomas (35.4%), followed by Degrees (28.5%), Certificates (13.8%), and a small minority with Masters (3.8%). This suggests that most are mid-career professionals with some tertiary-level training but not advanced postgraduate credentials. Prior research (e.g., in digital competence studies) often finds that higher qualifications are associated with greater exposure to technology in pre-service training or earlier adoption of innovations. Teachers with higher education may thus act as “early adopters” and peer mentors, playing key roles in cascading training or modelling the use of technology for others.

Age and years since qualification further nuance this picture. The largest age groups are 31–35 and 36–40 years; many teachers graduated in the years 2011–2015 and 2016–2020, with a smaller cohort from 2000–2010. This places many teachers in a middle stage of professional life: neither novices fresh from training nor close to retirement. The literature suggests that younger and more recently qualified teachers tend to adapt more quickly to technology. Studies such as Gangmei and Thomas [14] indicate that technological proficiency correlates with more recent educational experience and exposure. Additionally, Gil-Flores, Rodríguez-Santero and Ortiz-de Villate [15] found that age, experience, and qualification interact: younger teachers and those with more recent training tend to have more positive conceptions of ICT use and are more ready to integrate it.

This mixture of younger, recently qualified teachers and older, more experienced teachers suggests both opportunity and challenge: younger teachers may require less basic training and may serve as change agents, while older teachers may need more hands-on support, reinforcement, and mentoring.

5.2. Mobile phone awareness, use, and intent

A high proportion of teachers reported regular mobile phone use: 75.8% reported using their phones several times a week, and 13.3% reported daily use. This indicates widespread access and baseline familiarity with mobile devices, an essential precondition for any mobile PD, though not sufficient in itself. Literature on teacher digital literacy indicates that access to devices and basic usage (e.g., for communication or browsing) does not necessarily translate into readiness for pedagogical (educational) use. The scoping review by Gangmei and Thomas [14] highlights that although many teachers are comfortable with general ICT tools, integrating these tools into teaching (e.g., designing digital materials and implementing interactive/collaborative learning) often remains weak.

Despite high device use, willingness to use phones for learning was more mixed: about 37.5% were likely or very likely, 52.5% were unlikely or very unlikely, and the remainder were neutral. This suggests that for many teachers, mobile phones remain tools for social, personal, or communication purposes rather than for professional learning. Support for this is found in many studies that examine “use vs intention vs behaviour” in TAM, UTAUT, or related models. For example, Althubayani [4] found that limited access to tools and the availability of digital technology are major barriers, even when perceptions are positive.

The dominance of social and communicative use over educational app use is consistent with evidence that awareness of educational tools is often low, and that motivation, institutional support, and curriculum alignment all affect whether teachers reorient their mobile usage toward professional development.

5.3. Characteristics of mobile smartphone applications

5.3.1. Accessibility and compatibility of mobile application for teachers’ professional development

Across the four themes that emerged from the data, accessibility and compatibility surfaced as the strongest signals of teachers’ willingness to adopt mobile applications for professional development. The highest-rated item in this theme was compatibility with multiple devices and platforms ($M = 4.28$), underscoring the need for seamless functionality across the diverse smartphones used in rural schools. App size also shaped adoption ($M = 4.20$), with a clear preference for lightweight applications, while affordability was rated equally highly ($M = 4.20$), favouring free or low-cost options. High internet costs were rated as less critical ($M = 2.39$) but remained a barrier in areas with limited infrastructure. Together, these findings point to the accessibility and compatibility of mobile applications for teachers’ professional development as foundational preconditions for uptake. Although mobile technologies are increasingly available, challenges such as device diversity, high data consumption, and reliance on continuous connectivity can still limit their effectiveness.

For example, one respondent noted:

Most of us prefer mobile applications that work smoothly across different devices and do not consume too much data. If an app requires constant internet or is heavy to run, it becomes difficult for rural teachers like us to rely on it. (WEO, July 2024)

Similarly, the DSQAO stated:

Teachers in remote areas face real challenges with applications that are designed without considering device variety or offline use. Even small technical issues can discourage consistent usage. (DSQAO, July 2024)

The REO added:

Many schools do not have stable internet or modern devices. Applications must be lightweight, compatible with older smartphones, and functional offline to be truly useful for teacher development. (REO, August 2024)

These findings suggest that teachers' willingness to adopt mobile applications is strongly influenced by device compatibility and offline functionality. The literature further supports the potential of mobile applications to transform teacher professional development (TPD) by providing flexible, accessible, and context-sensitive learning opportunities. For instance, Dahri et al. [11] reported that mobile-based certification frameworks in Pakistan and Saudi Arabia enhanced accessibility and structured learning. Similarly, Al Bataineh, Banikalef and Albashtawi [2] highlighted that teachers prioritise multimedia content, up-to-date information, and classroom-relevant resources, demonstrating that pedagogical alignment drives engagement more than technology alone. Supporting this, Saif, Khan and Shaheen [35] found that mobile applications increased teacher performance by 51% in Pakistan by fostering motivation and positive attitudes.

Under the theme of interactivity and collaboration, teachers in our study reported a willingness to share experiences ($M = 3.99 \pm 0.97$) and to collaborate via mobile platforms ($M = 4.17 \pm 0.90$). These findings align with Pham et al. [31] and Cho et al. [8], who emphasised the influence of sociocultural and contextual factors, such as leadership support and collegiality, on TPD outcomes. Finally, our results on usability and language align with those of Kondoro et al. [20], confirming that mobile applications may be rejected despite their potential if user-friendly design and contextual adaptation are not given attention.

5.3.2. Content and relevance of mobile application for teachers' professional development

Content quality and curricular alignment emerged as a second decisive theme. Teachers reported that mobile apps are most useful when their content aligns with their teaching needs ($M = 4.18 \pm 0.88$), provides multimedia resources ($M = 4.10 \pm 0.93$), offers up-to-date and reliable information ($M = 4.20 \pm 0.87$), and supports the improvement of knowledge and teaching practices ($M = 4.23 \pm 0.86$). These findings indicate that relevant, interactive, and current content is key to effective professional development through mobile apps.

A key sub-theme that emerged from the data was content and relevance, which relates to how effectively mobile applications deliver meaningful, subject-specific, and pedagogically sound resources that meet teachers' professional needs. Participants consistently emphasised that the value of any mobile-based professional development tool depends on whether its content is accurate, contextualised, and directly applicable to classroom practices.

For professional development, the content must directly relate to what we teach in class. Applications with locally relevant examples, aligned with the curriculum, are far more valuable than those offering general or foreign content. (WEO, August 2024)

The significance of mobile-based frameworks in improving teacher professional development (TPD) is increasingly highlighted in both global and local research. Dahri et al. [11] created a mobile training and certification framework focused on mobile access, structured curricula, and CPD evaluation. Their pilot study, involving 35 educators from Pakistan and Saudi Arabia, found that 98% considered mobile learning more accessible and engaging than traditional methods. This supports the findings of the current study, in which teachers strongly agreed that the content and relevance of applications are crucial, particularly when app materials directly enhance teachers' knowledge and practice ($M = 4.23 \pm 0.86$). This indicates that relevance and structured content are key factors in teacher engagement.

5.3.3. Interactivity and collaboration of a mobile application for teachers' professional development

A third theme concerned interactivity and peer collaboration. Teachers valued mobile apps that support interaction and collaboration, with interactive features ($M = 4.13 \pm 0.91$) and collaborative tools ($M = 4.10 \pm 0.94$) rated as important. They also appreciated opportunities to share experiences ($M = 3.99 \pm 0.97$) and reported a willingness to collaborate with peers via apps ($M = 4.17 \pm$

0.90). These results highlight that fostering engagement and peer collaboration is key to effective professional development through mobile applications.

Similarly, collaborative features such as group discussions, forums, and peer-sharing platforms were viewed favourably because they enable teachers to share experiences, ask questions, and collaborate to address instructional challenges. One WEO explained:

The best part of mobile applications is when they allow us to interact, ask questions, and share ideas with other teachers. Collaboration through chat groups or forums makes learning practical, and it motivates us to keep using the app. (WEO, August 2024)

In the same context, another officer added:

Applications should not only provide content but also create spaces where teachers can learn from each other. That kind of collaboration gives us more confidence in applying what we learn. (DSQAO, August 2024)

The comments above indicate that teachers and education stakeholders consider interactive and collaborative features essential for ongoing professional development. They suggest that mobile applications providing peer-to-peer learning opportunities alongside individual study tools enhance both teacher motivation and pedagogical confidence. These findings align with international evidence. For instance, in Vietnam, Pham et al. [31] further emphasised the importance of collegial collaboration and context-specific professional dialogue as key elements of teacher development, even in resource-limited settings. From a theoretical perspective, social constructivist theory highlights that knowledge is co-created through interaction and dialogue [17]. Likewise, cognitive multimedia theory suggests that combining words, images, and interactive features helps maintain engagement and facilitates deeper understanding [21]. Consequently, this study concludes that mobile applications for teacher professional development should do more than deliver static content. They must incorporate interactivity and collaboration as core design principles, as these not only enhance engagement and motivation but also promote reflective practice, collegial learning, and sustained professional growth.

5.3.4. Usability and language of the mobile application for teachers' professional development

Finally, usability and language emerged as a fourth decisive theme. Teachers emphasised that mobile apps should be simple to use ($M = 4.21 \pm 0.87$), available in both English and Kiswahili ($M = 4.14 \pm 0.91$), and functional both online and offline ($M = 4.21 \pm 0.87$). They also expressed confidence in using apps effectively if properly trained ($M = 4.25 \pm 0.85$). These findings indicate that user-friendly design, bilingual support, and offline functionality are critical for adoption and effective use in professional development.

Interviews with stakeholders indicated that the usability and language of a mobile application are essential determinants of whether it will be adopted and regularly utilised for professional development. Respondents noted that many teachers in rural areas encounter difficulties with complex applications, especially when navigation is not intuitive or when the language employed does not reflect their everyday teaching environment. One WEO remarked:

Even if an application is abundant in resources, teachers will not utilise it if it is difficult to navigate. Simple design and clear instructions are essential. (WEO, August 2024)

Another officer highlighted the importance of language by stating:

If the application is only in English, many teachers may find it difficult to follow. When Kiswahili is included, it becomes easier and more relevant for them. (DSQAO, August 2024)

Similarly, the ZSQAQO emphasised the need for context-sensitive design, noting:

Teachers are more likely to engage with an application that uses familiar terms and examples from their daily teaching environment. Language and local relevance are key for sustained use. (ZSQAQ, August 2024)

These observations suggest that, for mobile applications to support professional development effectively, they must be user-friendly, accessible, and linguistically inclusive. Usability enables teachers to find content quickly, practise new skills, and engage in interactive activities without frustration, while linguistic suitability promotes inclusivity and sustained engagement. Kondoro et al. [20] noted that applications with multilingual features and culturally relevant content have experienced higher adoption rates in Sub-Saharan Africa.

6. Conclusion

This study shows that mobile smartphone applications can significantly enhance teacher professional development (TPD) in rural Tanzanian primary schools, provided they address technological, pedagogical, and contextual factors. Although most teachers have regular access to mobile phones, use is mainly for social purposes rather than learning, highlighting the need for targeted training. Pre-intervention assessments revealed limited knowledge and skills but moderately positive attitudes, with attitudes being the strongest predictor of perceptions, followed by knowledge and skills.

Teachers highlighted four key design principles: accessibility and compatibility, content and relevance, interactivity and collaboration, and usability and language. Light, affordable, and offline-capable apps support adoption; relevant, multimedia-rich, and curriculum-aligned content improves learning; interactive and collaborative features encourage peer engagement and reflective practice; and a user-friendly, bilingual design guarantees inclusivity. Stakeholder feedback underlined the importance of context-sensitive design and local relevance.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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