Evaluating the Influence of Tutors' Digital Assessment-Related Knowledge on Assessment Practices in Higher Education

Justice Dadzie, Ifesinachi Jude Ezugwu, Ivy Ama Kpodoe, Daniel Kweku Anhwere, Frank Oppong and Daniel Oyeniran

Abstract
This research study investigates the influence of tutors' digital assessment pedagogical knowledge on various assessment practices, including automated, continuous, responsible, and authentic assessments. The results indicate that Digital Assessment Pedagogical Knowledge (DA_PK) has a significant influence on Automated Assessment (R2 = 0.823) and Continuous Assessment (R2 = 0.753), highlighting the importance of tutors' proficiency in digital assessment practices for enhancing student learning experiences. Additionally, the findings reveal that Digital Assessment Pedagogical Content Knowledge (DA-PCK) explains 93% of the variation in Continuous Assessment and 34.1% of the variation in Automated Assessment, emphasizing the critical role of integrating technology, pedagogy, and content expertise in shaping effective assessment strategies. Furthermore, Digital Assessment Technological Pedagogical Knowledge (DA-TPK) demonstrates a remarkable influence, accounting for 96.5% of the variation in responsible assessment and 43.4% of the variation in continuous assessment, underscoring the significance of tutors' technological and pedagogical knowledge in fostering ethical, accountable, and continuous assessment practices.

Keywords: digital assessment pedagogical knowledge, assessment practices, higher education, tutors' proficiency, student learning experiences, educational excellence

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promote student engagement, learning outcomes, and educational excellence in the digital age.

Résumé: Cette étude examine l'influence des connaissances pédagogiques des tuteurs en matière d'évaluation numérique sur diverses pratiques d'évaluation, notamment l'évaluation automatisée, l'évaluation continue, l'évaluation responsable et l'évaluation authentique. Les résultats indiquent que les connaissances pédagogiques en matière d'évaluation numérique (DA_PK) influencent significativement l'évaluation automatisée (R2 = 0,823) et l'évaluation continue (R2 = 0,753), soulignant l'importance de la maîtrise des pratiques d'évaluation numérique par les tuteurs pour améliorer les expériences d'apprentissage des étudiants. En outre, les résultats révèlent que les connaissances pédagogiques en matière d'évaluation numérique (DA-PCK) expliquent 93 % de la variation dans l'évaluation continue et 34,1 % de la variation dans l'évaluation automatisée, soulignant le rôle essentiel de l'intégration de la technologie, de la pédagogie et de l'expertise en matière de contenu dans l'élaboration de stratégies d'évaluation efficaces. En outre, les connaissances technologiques et pédagogiques en matière d'évaluation numérique ont une influence remarquable, représentant 96,5 % de la variation dans l'évaluation responsable et 43,4 % de la variation dans l'évaluation continue, soulignant l'importance des connaissances technologiques et pédagogiques des tuteurs dans la promotion de pratiques d'évaluation éthiques, responsables et continues. Les résultats de l'étude révèlent l'interdépendance entre la pédagogie, l'expertise en matière de contenu et la technologie dans l'élaboration de pratiques d'évaluation qui favorisent l'engagement des étudiants, les résultats d'apprentissage et l'excellence éducative à l'ère numérique.

Mots clés: connaissances pédagogiques en matière d'évaluation numérique, pratiques d'évaluation, enseignement supérieur, compétences des tuteurs, expériences d'apprentissage des étudiants, excellence éducative

Introduction

The COVID-19 pandemic has undoubtedly accelerated the integration of digital technologies in education, but the design and implementation of digital assessments have not kept pace with this rapid transformation. Before the pandemic, higher education institutions (HEIs) predominantly relied on traditional assessment methods such as multiple-choice questions, essays, and short-answer tests to evaluate student learning (Dadzie et al., 2024; Swiecki et al., 2022). However, the abrupt transition to remote and online learning during the pandemic exposed significant

limitations in these conventional practices, particularly among contact-based programmes.

In contrast, distance-based higher education institutions (HEIs), which had already developed sophisticated online assessment systems, demonstrated greater resilience and adaptability during the pandemic (Amponsah et al., 2024; Gamage et al., 2022; Rapanta et al., 2021). These institutions leveraged their prior experience with digital platforms to implement assessments that emphasised flexibility, accessibility, and continuous feedback, mitigating many of the challenges faced by contact-based programmes. Recent studies highlight how distance-based HEIs effectively integrated alternative assessments such as project-based evaluations, authentic assessments, and e-portfolios to maintain academic integrity and enhance student engagement (Annan-Brew et al., 2024; Bozkurt & Sharma, 2022; Tonbuloglu, 2023).

Research has shown that the predominant strategy adopted by educators was to simply "translate" their existing on-campus assessments into an online format, rather than exploring the transformative potential of digital technologies to design pedagogically sound and innovative assessment approaches (Kpodoe et al., 2023; Slade et al., 2022;). This reluctance to embrace the full capabilities of digital tools in assessment design may indicate a lack of understanding or confidence among educators in leveraging technology to enhance the assessment process. As Bearman et al. (2023) aptly state, "Digital technologies have transformed society but assessment design may not have kept pace with the digital world" (p. 291). Nonetheless, there is promising potential in the use of online assessments to support and improve the overall learning process and outcomes, as highlighted by Heil and Ifenthaler (2023). By harnessing the power of digital technologies, educators can design assessments that are more engaging, personalized, and aligned with the evolving needs of students in the digital age.

In higher education, educators play a pivotal role in ensuring that teaching methods and assessment strategies are effectively aligned with the curriculum, while also integrating digital technologies in pedagogically sound ways to facilitate student teaching (Alajlani et al., 2023; Dadzie, & Ahorsu-Walker, 2022). The onset of the COVID-19 pandemic resulted in significant disruptions to traditional teaching and assessment practices, leading to a widespread shift towards online assessment methods in higher education settings (Chan & Ahn, 2023; Slade et al., 2022). This transition to online assessment brought about both opportunities and challenges for

educators. On one hand, it offered benefits such as increased efficiency in time management, enhanced flexibility, and the ability to provide immediate feedback to students (Dadzie, & Annan-Brew, 2023; Gorgani & Shabani, 2021). However, on the other hand, it also presented numerous challenges and concerns. Issues surrounding student privacy, trust, fairness, equity, and security emerged as significant considerations for educators and other stakeholders involved in digital assessment processes in higher education (Coghlan et al., 2021; Gorgani & Shabani, 2021; Lee and Fanguy, 2022; Woldeab & Brothen, 2021).

Assessment serves several important purposes in education, including evaluating learner achievement, maintaining academic standards, ensuring accountability, and promoting student learning (Chan, 2023a). Over the past decade, the landscape of assessment in higher education has evolved significantly, particularly with the widespread adoption of digital technologies, accelerated by the COVID-19 pandemic (Chan, 2022; Guangul et al., 2020). This includes the emerging popularity of generative AI (GenAI) technologies in assessment practices (Dontoh et al., 2023 Farazouli et al., 2023; Moorhouse et al., 2023;). The shift towards digital assessment practices is expected to have lasting implications beyond the pandemic, fundamentally altering how assessments are conducted in higher education settings (Zhang & Wang, 2021). As such, there is a critical need to support educators in designing effective digital assessments that align with educational objectives and best practices. Scholars emphasize that the integration of digital technologies in assessment has led to significant changes in assessment instruments, criteria, feedback delivery methods, and student involvement in the assessment process, including self- and peer assessment (Panadero et al., 2022; Sandvik et al., 2023).

When exploring the role of digital technologies in assessment, the term "e-assessment" has traditionally been used to encompass all assessment tasks conducted using computers or the web (Guàrdia et al., 2017, p. 38). However, the terminology surrounding digital assessment practices, including online assessment, remote assessment, and digital assessment, is often used interchangeably without clear distinctions (Bearman et al., 2023; Guangul et al., 2020; Heil and Ifenthaler, 2023; Lee et al., 2022;). This lack of clarity poses challenges in understanding the nuanced roles and effects of digital technologies in assessment, as different technologies offer diverse user experiences and affordances. The emergence of generative AI technologies presents both opportunities and challenges in transforming assessment practices (Cotton et al., 2023). While GenAI enables the creation of personalized, interactive, and game-based assessments, it also

raises concerns related to academic integrity and equity (Nikolic et al., 2023; Sandvik et al., 2023). To address these issues, it is crucial to establish a clear understanding of digital assessment, encompassing both formative and summative, graded, and non-graded assessment practices that leverage digital technologies (Bearman et al., 2016; Dadzie, 2022; Feyijimi et al., 2025).

In this study, we use continuous assessment to refer to the frequent and ongoing evaluation of student learning throughout the instructional period, which often includes both formative assessments (aimed at improving learning during instruction) and low-stakes summative assessments (used to judge achievement at various stages). While continuous assessment shares characteristics with formative assessment, it more broadly encompasses any regular assessment activity designed to track student progress over time.

The current study seeks to investigate the impact of digital assessment pedagogical knowledge (DA-PK), digital assessment pedagogical content knowledge (DA-PCK), and digital assessment technological pedagogical knowledge (DA-TPK) on various assessment practices. Specifically, we hypothesize that:

1, Digital assessment pedagogical knowledge (DA-PK) will significantly influence assessment practices, including authentic assessment, automated assessment, continuous assessment, and responsible assessment.

2, Digital assessment pedagogical content knowledge (DA-PCK) will significantly influence assessment practices, including authentic assessment, accessible assessment, automated assessment, and continuous assessment.

3, Digital assessment technological pedagogical knowledge (DA-TPK) will significantly influence authentic assessment, continuous assessment, and responsible assessment.

Literature Review

Tutors' Digital Assessment Practices

College tutors play a crucial role in assessment practices, particularly in assessment for learning, where the primary focus is on enhancing students' learning experiences (Gioka, 2007; Zhang, 2022). Assessment for learning encompasses not only the communication and implementation of assessment criteria by tutors but also the necessary adaptations to meet students' diverse needs effectively (Zhang, 2022). Previous research has highlighted the challenges faced by tutors in implementing digital assessment practices for learning, highlighting the need for ongoing

support and solutions (Slade et al., 2022). During the pandemic, tutors encountered various barriers, including pedagogical, technical, administrative, and affective obstacles, in conducting digital assessments (Ghanbari and Nowroozi, 2021; Surman et al., 2024; Surman et al., 2024). Addressing these challenges is essential in the post-COVID era to ensure effective digital assessment practices. Furthermore, concerns regarding privacy, trust, fairness, equity, and security have been raised among stakeholders, including tutors, regarding digital assessment practices (Coghlan et al., 2021; Cotton et al., 2023; Gorgani and Shabani, 2021; Lee and Fanguy, 2022; Woldeab and Brothen, 2021; Ifesinachi et al., 2024). These concerns emphasize the importance of responsible and ethical use of digital technologies in assessment for learning.

Examination of tutors' digital assessment practices in higher education

To date, research on university tutors' digital assessment practices remains limited, with only a few studies exploring this area (Zhang and Wang, 2021). Among these studies, qualitative methods, particularly semi-structured interviews, have been predominantly utilized (Gupta et al., 2023; Moorhouse and Kohnke, 2022; Zhang and Wang, 2021). Additionally, there is a scarcity of studies employing mixed methods approaches (Vellanki et al., 2023). For instance, Gupta et al. (2023) investigated the digital assessment experiences of 31 faculty members in American higher education using semi-structured interviews. Their findings highlighted five key themes related to assessment techniques adopted during the COVID-19 pandemic, including assignments, self-check tests, group discussions, peer-tutorial videos, and case studies. Similarly, Zhang and Wang (2021) examined the digital assessment practices of six tutors in Chinese higher education through interviews. They discovered that tutors, when granted autonomy by the government and university, could make independent assessment decisions and adjustments to align with policies or provide digital assessment training.

Vellanki et al. (2023) explored university tutors' perceptions of digital assessment and academic integrity using interviews and a survey involving 37 tutors. Their findings revealed technical difficulties and other challenges arising from the lack of physical presence, student behaviour, and concerns about assessment design and processes. Furthermore, Farazouli et al. (2023) investigated the impact of AI chatbots on university tutors' assessment practices. In a Turing Test-inspired experiment involving 24 tutors, those who blindly assessed student- and ChatGPT-written responses to home examination questions demonstrated greater criticality when grading student-generated text.

While TPACK by Mishra and Koehler (2006) originally conceptualized "Technology" to include various forms of technology, it did not explicitly account for the rapid expansion of specialized digital assessment technologies that have emerged in contemporary education. The increasing integration of digital platforms for assessment such as learning management systems, online quizzes, automated feedback systems, and AI-based grading tools has created unique pedagogical demands distinct from general technological use in teaching. Therefore, in this study, we adapted TPACK to specify Digital Assessment Pedagogical Knowledge (DA-PK), Digital Assessment Pedagogical Content Knowledge (DA-PCK), and Digital Assessment Technological Pedagogical Knowledge (DA-TPK). This adaptation allows for a more precise examination of educators' ability to apply digital tools specifically for assessment purposes, addressing a critical gap in the traditional TPACK framework, which does not differentiate between technology used for instruction versus technology used for assessment. Despite these efforts, existing studies offer limited insights into tutors' digital assessment practices. The paucity and lack of scalable generalizability of research in this area is exacerbated by the limited number of participants.

Conceptual Framework

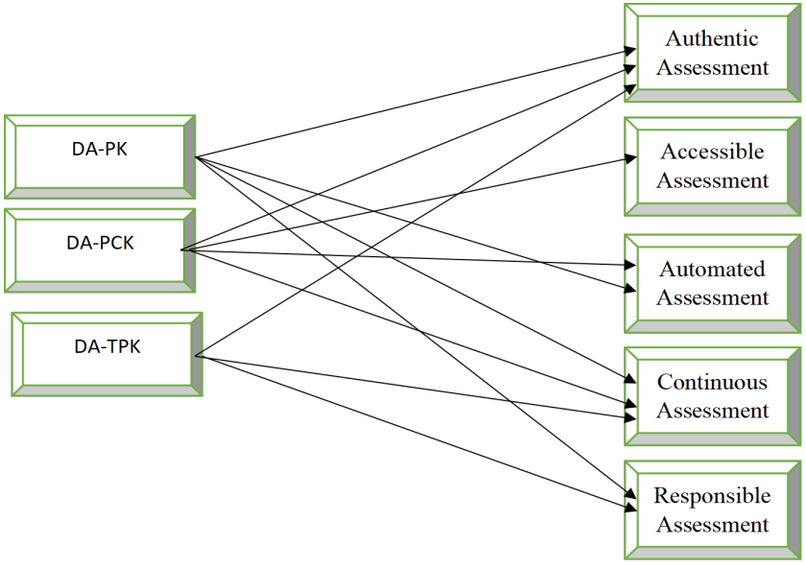

Figure 1

Authors Construct

The conceptual framework delineates the relationships between dependent variables, namely DA-PK, DA-PCK, and DA-TPK, and independent variables, including authentic, accessible, automated, continuous, and responsible assessments. Based on this framework, it can be inferred that DA-PK will exert influence on authentic, automated, continuous, and responsible assessments. This inference stems from the understanding that DA-PK encompasses deep knowledge about pedagogical practices in digital assessment, enabling tutors to implement various assessment methods effectively and adapt them to different student needs and courses (Mishra and Koehler, 2006). Similarly, DA-PCK is expected to influence authentic, accessible, automated, and continuous assessments. DA-PCK involves understanding how digital assessment approaches align with specific content and support student learning (Mishra and Koehler, 2006). This knowledge enables tutors to develop appropriate digital assessment methods that enhance students' critical thinking and consolidate their knowledge across different content areas. In contrast, DA-TPK is anticipated to influence authentic assessment alone. DA-TPK pertains to tutors' knowledge of digital technologies' capabilities and their impact on assessment practices (Mishra and Koehler, 2006). Thus, it directly affects how tutors incorporate digital technologies into authentic assessment tasks, ensuring their alignment with pedagogical goals and educational outcomes. Overall, the conceptual framework underscores the intricate interplay between tutors' digital assessment knowledge and various assessment practices, highlighting the pivotal role of pedagogical knowledge, content knowledge, and technological knowledge in shaping effective digital assessment strategies.

Methods

The study spanned three educational institutions situated in Ghana's Central Region, carefully selected for their congruence in tutor demographics and academic resources. These colleges primarily cater to the training of prospective educators and boast similar academic calendars and amenities. Employing a cross-sectional design, the research aimed to capture a singular moment's overview of college tutors' DA-PK, DA-PCK, and DA-TPK. Within the Central Region, three public colleges collectively host 150 tutors: College A (50 tutors), College B (45 tutors), and College C (55 tutors). The study specifically recruited tutors from these institutions. Data gathering utilized a comprehensive census approach, involving all eligible participants. Out of the initial 150 tutors approached, 120 willingly engaged in the study, demonstrating a robust participation rate. Prior to the main data collection phase, a pilot test was conducted with 45 tutors from

Holy Child College in Sekondi-Takoradi to refine and validate the survey items.

Predicator(s) Variable in the study

In the study, the dependent variable encompasses the constructs of DA-PK, DA-PCK, and DA-TPK. These constructs collectively represent the level of understanding, proficiency, and skills that educators possess in utilizing digital technologies for assessment purposes within the context of teaching and learning.

DA-PK: This aspect focuses on educators' knowledge and skills related to the pedagogical aspects of digital assessment. It includes their understanding of various assessment methods, strategies for providing effective feedback, and the ability to adapt assessment practices to meet diverse student needs using digital tools.

DA-PCK: This dimension pertains to educators' knowledge and expertise in integrating subject matter content with digital assessment practices. It involves their understanding of how to design assessments that effectively measure students' understanding of specific content areas using digital tools and resources.

DA-TPK: This construct focuses on educators' knowledge and proficiency in utilizing digital technologies for assessment purposes. Familiarity with various digital assessment tools, platforms, and technologies, as well as their ability to integrate these tools seamlessly into their teaching practices to enhance assessment processes and outcomes are the tenants-TPK.

Overall, these dependent variables reflect the comprehensive knowledge and skills that educators need to effectively implement digital assessment practices in educational settings, encompassing both pedagogical principles and technological competencies.

Dependent Variable(s)

In the study, the independent variables consist of five constructs related to assessment practices, namely authentic, accessible, automated, continuous, and responsible assessments. These constructs represent different dimensions or aspects of assessment practices that may influence or be influenced by educators' digital assessment knowledge and skills.

Authentic assessment refers to the use of real-world tasks that mirror the complexity of professional activities, requiring students to apply their knowledge and skills meaningfully. Rather than relying solely on traditional tests, authentic assessments engage learners in projects, case studies, and problem-solving activities that simulate future workplace demands (Gulikers et al., 2023; Wiggins, 2022). These assessments aim to foster deeper learning and transferability of skills across contexts.

Accessible assessment encompasses practices designed to ensure that all students, regardless of ability, background, or learning needs, can participate fully and equitably. According to Burgstahler and Cauce (2020), accessible assessments require flexible delivery formats, accommodations for disabilities, and culturally responsive materials that account for diverse learner profiles. Implementing Universal Design for Learning (UDL) principles has become a key strategy in making assessments more inclusive.

Automated assessment involves leveraging digital technologies such as artificial intelligence (AI), machine learning, and online platforms to streamline grading, provide immediate feedback, and analyse student performance patterns. Research by Spector and Ifenthaler (2023) emphasizes that automated assessments can enhance efficiency and consistency while offering personalized feedback at scale, though, scholars caution that human oversight remains critical to maintaining validity and fairness.

Continuous assessment emphasizes the ongoing monitoring and evaluation of students' progress throughout the instructional period. It replaces the high-stakes, one-time exam model with a series of low-stakes assessments that offer timely feedback and opportunities for improvement (Carless, 2023). Continuous assessment supports formative learning processes by encouraging reflection, self-regulation, and sustained engagement over time.

Responsible assessment refers to ethical, fair, and transparent assessment practices that safeguard student rights, privacy, and data security. Scholars such as Tai et al. (2023) stress that responsible assessment practices require informed consent, secure handling of digital data, and adherence to institutional and legal standards. Responsible assessment also emphasizes fairness and accountability in evaluating diverse learners' performances.

Overall, these independent variables represent various aspects of assessment practices that educators may employ in their teaching contexts, each potentially influencing the implementation and outcomes of digital assessment practices.

Instrument

Our research delved into the digital assessment practices of college tutors, utilizing the TPACK framework developed by Mishra and Koehler (2006). Widely regarded as a foundational concept in educational technology, TPACK captures the essential domains of teacher knowledge for technology integration (Mishra et al., 2023). To align this framework with the specific demands of digital assessment in higher education, we drew on the work of Viberg et al. (2024), who adapted TPACK to focus explicitly on digital competence in assessment contexts. Their study introduced and validated an instrument that measured digital pedagogical knowledge, content-specific knowledge for assessment, and technological application in assessment. We adopted this instrument with minor contextual modifications to reflect the higher education setting in our study. The adapted version retained the core constructs of DA-PK, DA-PCK, and DA-TPK and served as the basis for our data collection.

In higher education, digital assessment hinges on tutors' proficiency in technological, pedagogical, and content domains, coupled with their understanding of the potentials and limitations of such assessment methods (Annan-Brew et al., 2023; Mimirinis, 2019; Slade et al., 2022). Given the intricate and multifaceted nature of teacher knowledge required for effective technology integration, the TPACK framework provides a holistic approach by being rooted in pedagogical content knowledge (PCK) as proposed by Shulman (1986). This knowledge encompasses the skills and understanding that tutors need to effectively teach a particular subject matter. Adaptation of the TPACK framework for various purposes, as highlighted by Celik (2023), underscores its flexibility and applicability across different educational contexts. Our study specifically focused on the pedagogical practice of digital assessment, emphasizing pedagogical knowledge (PK), pedagogical content knowledge (PCK), and technological pedagogical knowledge (TPK) as relevant components within the TPACK framework. As emphasized by Swiecki et al. (2022), there remains limited understanding of the pedagogical role of assessment, underscoring the importance of our investigation into preservice tutors' digital assessment practices within this theoretical framework.

In this study, we operationalized the three pedagogical constructs of the TPACK framework PK, PCK, and TPK to specifically address the pedagogical practice of digital assessment. To ensure alignment with our study's focus, we renamed these constructs as follows: DA-PK, DA-PCK, and DA-TPK. DA-PK encompasses tutors' deep understanding of the processes, practices, and methods of digital assessment, including its educational purposes,

values, and aims (Mishra and Koehler, 2006). This construct evaluates tutors' ability to implement diverse pedagogical approaches to assess students using digital technologies, adapt digital assessment methods to varying student needs and course requirements, and employ a range of digital formative and summative assessment activities in their teaching practices. DA-PCK involves knowing which digital assessment approaches are suitable for specific content areas and understanding how these approaches can be aligned to support student learning effectively (Biggs, 1996; Mishra and Koehler, 2006). Through this construct, we aimed to assess tutors' capacity to develop digital assessment methods that promote complex thinking among students and consolidate their knowledge within the context of different subjects. DA-TPK pertains to tutors' knowledge of the various technologies available for digital assessment, including their components, capabilities, and potential impact on assessment practices (Mishra and Koehler, 2006). This construct evaluates whether tutors can select digital tools that enhance assessment practices and facilitate student learning. Additionally, it assesses tutors' ability to adapt the use of digital technologies to different assessment activities, ensuring alignment with pedagogical goals and student needs. While assessment strategies are traditionally embedded within pedagogical knowledge, the growing complexity and technological integration of assessment in digital learning environments necessitates their explicit treatment as a distinct focus. By adapting and operationalizing assessment-specific constructs within the TPACK framework namely, DA-PK, DA-PCK, and DA-TPK, our study aimed to provide a targeted and comprehensive evaluation of college tutors' competencies in digital assessment. This approach contributes to a more nuanced understanding of pedagogical practice in the digital age.

The second segment of our instrument delves into tutors' perspectives on what we refer to as the 'future' of digital assessment. This section comprises several key constructs: authentic, accessible, automated, continuous, and responsible assessments. We derived and modified the first four constructs from the comprehensive report titled 'The Future of Assessment: Five Principles, Five Targets for 2025' (Pauli and Ferrell, 2020). These constructs have also been informed by additional literature (Farazouli et al., 2023; Swiecki et al., 2022), ensuring a robust foundation for our investigation into the evolving landscape of digital assessment.

The construct of authentic assessment encompasses items designed to gauge whether tutors incorporate digital assessment into real-world scenarios, facilitate peer feedback through digital technologies, or integrate augmented or virtual reality into digital assessment practices. Authentic

assessment is defined as a method of preparing learners for future endeavours by aligning assessments with real-world contexts, meeting employer demands, and evaluating knowledge and skills in a realistic and motivating manner (Pauli and Ferrell, 2020). It emphasizes the application of competencies relevant to professional life, ensuring that learners utilize the same skills, knowledge, and attitudes required in real-world situations (Gulikers et al., 2004). However, Nieminen et al. (2023) highlight that while 'the digital' should play a central role in the design of authentic assessment, their literature review findings, comprising 55 papers, indicate that the digital component has not been adequately addressed in existing research.

The accessible assessment construct encompasses items designed to evaluate the accessibility of digital assessments, both in general and specifically for students facing various challenges such as anxiety, visual impairment, or special needs. Accessible assessment practices aim to ensure that assessments are usable by everyone to the greatest extent possible, including individuals with disabilities or mental health challenges (Pauli and Ferrell, 2020). These practices contribute to assessment for inclusion, fostering the full participation of marginalized students in academic communities and promoting student equity (Nieminen, 2022; Tai et al., 2023). Despite the significance of designing assessments for inclusion and equity, limited research has focused on related assessment practices (Ajjawi et al., 2023; Dadzie et al., 2025).

The automated assessment construct focuses on assessing whether tutors utilize automated assessment mechanisms or digital tools for personalized learning, real-time feedback, or adaptive feedback. Automated assessments aim to alleviate tutors' workload in marking and providing feedback while offering students quicker, more detailed, and actionable feedback (Pauli and Ferrell, 2020). These assessments often leverage AI techniques driven by deep neural networks (Swiecki et al., 2022) and have been implemented in various educational contexts, such as programming education, where they correct coding tasks and offer continuous feedback (Dunder et al., 2024; Pearson and Penna, 2023).

Continuous assessment involves evaluating whether tutors employ digital assessments consistently throughout courses, using those multiple times instead of a final exam, and keeping students informed about their learning progress. Continuous assessment aligns with the notion of lifelong learning and provides ample practice opportunities for students, reducing reliance on high-stakes exams (Pauli and Ferrell, 2020). AI-powered educational tools, including electronic assessment platforms and computerized adaptive testing systems, support continuous assessment by offering adaptive assessments and facilitating the collection of comprehensive data on students' learning processes (Pardos et al., 2023; Swiecki et al., 2022).

Responsible assessment pertains to tutors' obligations to safeguard student privacy and data by institutional and legal regulations (Terpsta et al., 2023). This construct evaluates whether tutors take appropriate measures to protect student privacy, securely store data, and refrain from sharing student assessment data, ensuring compliance with university data protection regulations.

Table 1: Reliability and Validity Measures for Constructs

	Cronbach's alpha
Authentic Assessment (AA)	0.866
Accessible Assessment (ACA)	0.825
Automated Assessment (AUA)	0.605
Continuous Assessment (CA)	0.894
Responsible Assessment (RA)	0.809
Overall	0.930

Source: Fieldwork (2024)

A Cronbach's alpha values offer insights into the internal consistency reliability of the constructs in the study. With Cronbach's alpha of 0.866, authentic assessment (AA) demonstrates strong internal consistency, indicating that the items measuring this construct are reliable and consistent in capturing the intended characteristic. Accessible assessment (ACA) follows suit with Cronbach's alpha of 0.825, reflecting good internal consistency among its items. In contrast, automated assessment (AUA) shows a lower Cronbach's alpha of 0.605, suggesting some variability or inconsistency in responses across its items. Continuous assessment (CA) exhibits high internal consistency with Cronbach's alpha of 0.894, indicating strong agreement among its items. Responsible assessment (RA) also demonstrates good internal consistency with Cronbach's alpha of 0.809. The overall Cronbach's alpha of 0.930 across all constructs signifies strong internal consistency reliability in the measurement instruments used in the study. These results highlight the reliability of most constructs, with automated assessment (AUA) standing out for its lower internal consistency compared to the other constructs. This pilot phase aimed to enhance the reliability and validity of the research instrument.

Result

Research Hypothesis One: DA-PK will significantly influence assessment practices, including authentic, automated, continuous, and responsible assessments.

While accessible assessment is an important aspect of assessment practice, it was intentionally excluded from Hypothesis One based on theoretical alignment. Recent literature suggests that DA-PK primarily influences pedagogical functions closely tied to instructional design and learner engagement (Spector and Ifenthaler, 2023; Viberg et al., 2024;), whereas accessible assessment is more often driven by institutional policies and infrastructure than by individual pedagogical knowledge. Before the analysis was conducted, the research hypothesis was that DA-PK would influence various assessment practices, including authentic assessment (AA), automated assessment (AUA), continuous assessment (CA), and responsible assessment (RA). This hypothesis was based on the understanding that tutors' pedagogical knowledge and skills related to digital assessment are critical for effectively integrating technology into assessment processes. The literature suggests that tutors' DA-PK can shape how they design, implement, and evaluate different assessment approaches, potentially leading to more authentic, automated, continuous, and responsible assessment practices. The analysis of the R2 and adjusted R2 values was intended to provide empirical evidence to support or refute this hypothesis, by examining the extent to which the independent variable of DA-PK explains the variation in the dependent variables representing the different assessment approaches (see Figure 2 and Table 2).

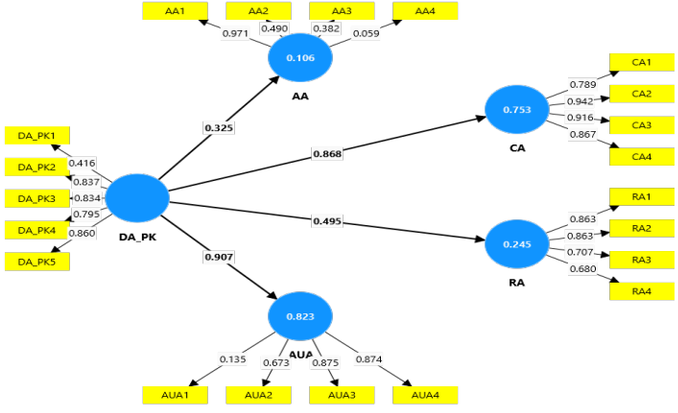

Figure 2

Path analysis

Table 2: Regression Analysis Results for the Influence of Digital Assessment Pedagogical Knowledge on Assessment Approaches

	R-square	R-square adjusted
Authentic Assessment (AA)	0.106	0.098
Automated Assessment (AUA)	0.823	0.822
Continuous Assessment (CA)	0.753	0.751
Responsible Assessment (RA)	0.245	0.239

Source: Fieldwork (2024)

The analysis of the R2 and adjusted R2 values provides valuable insights into the influence of the independent variable, DA-PK, on the dependent variables representing different assessment approaches. The results indicate that DA-PK has the strongest influence on automated assessment (AUA) and continuous assessment (CA). The R2 values of 0.823 and 0.753, respectively, suggest that DA-PK explains a substantial proportion of the variation in these assessment variables, with 82.3% of the variation in AUA and 75.3% of the variation in CA being accounted for by the independent variable. The adjusted R2 values, which are close to the R2 values, further confirm the strong fit of the models, indicating that the inclusion of DA-PK as a predictor significantly enhances the explanatory power of the models for these assessment approaches.

In contrast, the influence of DA-PK on responsible assessment (RA) and authentic assessment (AA) is relatively weaker, with R2 values of 0.245 and 0.106, respectively. This suggests that while DA-PK plays a role in these assessment domains, other factors beyond the tutors' digital assessment pedagogical knowledge may be more influential in shaping these assessment practices. The slightly lower adjusted R2 values compared to the R2 values for RA and AA indicate the possibility of some overfitting in the models, which should be further investigated. These findings underscore the critical importance of developing and strengthening tutors' digital assessment-related pedagogical competencies, as their knowledge and skills in this area have a significant impact on the implementation and effectiveness of automated and continuous assessment approaches. The results highlight the need for targeted professional development and training programmes to equip tutors with the necessary DA-PK to enhance assessment practices and support student learning.

Research Hypothesis Two: DA-PCK will significantly influence assessment practices, including authentic, accessible, automated, and continuous assessments.

While responsible assessment is undoubtedly a critical element of assessment practice, it was deliberately excluded from this hypothesis. Existing research suggests that responsible assessment encompassing ethical concerns, data privacy, and institutional compliance is shaped more by institutional regulations and legal frameworks than by content-specific pedagogical knowledge (Bearman et al., 2023; Lu et al., 2024). DA-PCK focuses on how educators integrate content with pedagogical strategies using technology and thus has stronger theoretical alignment with assessment practices like authentic, automated, accessible, and continuous assessments, where content and learner engagements are central (Viberg et al., 2024). Before conducting the analysis, the research hypothesis posited that DA-PCK would have an influence on various assessment practices, including authentic, accessible, automated, and continuous assessments. This hypothesis was grounded in the belief that tutors' proficiency in digital assessment pedagogy plays a crucial role in shaping assessment practices in higher education. The study aimed to explore how tutors' perceptions of their pedagogical digital assessment knowledge influence the design, implementation, and effectiveness of different assessment approaches. The analysis sought to investigate the influence of tutors' DA-PCK and the application of diverse assessment methods, with a focus on authentic, accessible, automated, and continuous assessment practices during online assessment (see Figure 3 and Table 3).

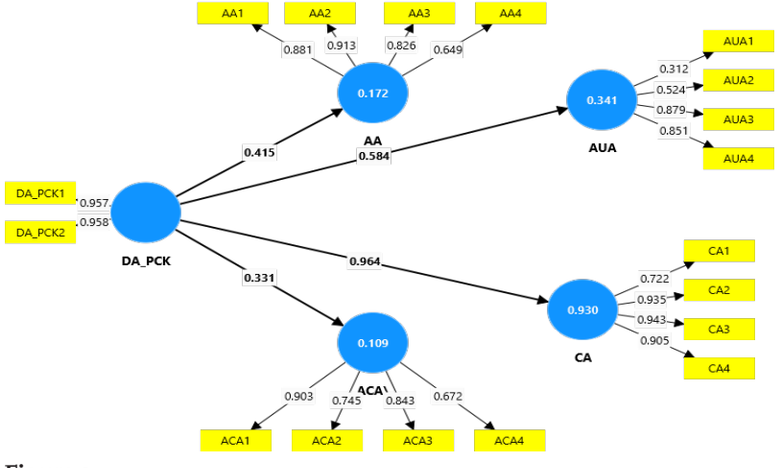

Figure 3

Path analysis

Table 3: Regression Analysis Results for the Influence of Digital Assessment Pedagogical Content Knowledge on Assessment Approaches

	R-square	R-square adjusted
Authentic Assessment (AA)	0.172	0.165
Accessible Assessment (ACA)	0.109	0.102
Automated Assessment (AUA)	0.341	0.336
Continuous Assessment (CA)	0.93	0.93

Source: Fieldwork (2024)

The significant impact of DA-PCK on continuous assessment (CA) and automated assessment (AUA) underscores the pivotal role of educators' proficiency in digital assessment pedagogy in shaping assessment practices. The substantial 93% variation explained by DA-PCK in continuous assessment highlights its direct and robust relationship with this assessment approach, indicating a strong influence on evaluating students' progress and learning outcomes continuously. Moreover, the notable 34.1% variation explained by DA-PCK in automated assessment emphasizes its importance in enhancing automated assessment practices, highlighting its ability to streamline assessment processes and provide efficient feedback mechanisms.

While the influence of DA-PCK on authentic assessment (AA) and accessible assessment (ACA) appears comparatively weaker, explaining 17.2% and 10.9% of the variation, respectively, these results still signify a significant impact on these assessment approaches. The moderate influence on authentic and accessible assessments suggests that DA-PCK fosters authenticity and accessibility in assessment practices, albeit less than continuous and automated.

Overall, these findings provide compelling evidence supporting the critical role of educators' DA-PCK in driving effective assessment strategies. By enhancing tutors' proficiency in digital assessment pedagogy, educational institutions can optimize assessment practices, promote continuous improvement in student learning, and adapt to the evolving landscape of education in the digital age. The emphasis on continuous and automated assessment practices underscores the need for educators to prioritize digital assessment skills to ensure the effectiveness and efficiency of assessment processes, enhancing educational outcomes and student success.

Research Hypothesis Three: DA-TPK will significantly influence authentic assessment, continuous assessment, and responsible assessment.

This hypothesis excludes accessible and automated assessments to maintain theoretical precision. While DA-TPK concerns the integration of technology with pedagogy, recent literature emphasizes its strongest influence on practices that involve direct instructional design using digital tools such as authentic and continuous assessments (Viberg et al., 2024). Accessible assessment, by contrast, is often institutionally or systemically driven, and automated assessment is more aligned with DA-PCK, where technology is mapped onto specific content domains (Spector and Ifenthaler, 2023). Therefore, the selection of constructs in this hypothesis reflects differentiated pathways supported by theoretical models in recent digital assessment literature. Before conducting the analysis, the research hypothesis posited that DA-TPK would have an influence on specific assessment practices, namely authentic, continuous, and responsible assessments. This hypothesis was formulated based on the understanding that educators' proficiency in leveraging technology for pedagogical purposes plays a crucial role in enhancing assessment practices that focus on authenticity, continuity, and responsibility in evaluating student learning outcomes. The study aimed to investigate how tutors' DA-TPK influences the implementation and effectiveness of these specific assessment approaches, with a focus on promoting authentic, continuous, and responsible assessment practices in educational settings (see Figure 4, Table 4).

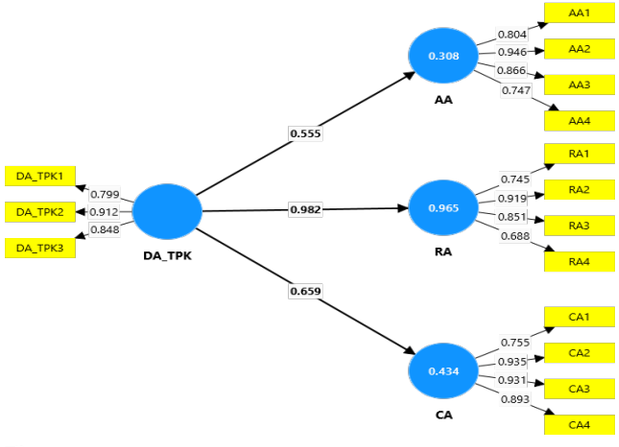

Figure 4
Path analysis

Table 4: Regression Analysis Results for the Influence of Digital Assessment Technological Pedagogical Knowledge on Assessment Approaches

	R-square	R-square adjusted
Authentic Assessment (AA)	0.308	0.302
Continuous Assessment (CA)	0.434	0.429
Responsible Assessment (RA)	0.965	0.965

Source: Fieldwork (2024)

The regression analysis results presented in Table 4 provide compelling evidence for the significant influence of DA-TPK on various assessment approaches. The findings reveal that DA-TPK has the strongest impact on responsible assessment (RA), explaining a remarkable 96.5% of the variation in this assessment practice, as indicated by the exceptionally high R2 and adjusted R2 values of 0.965. This exceptional result underscores the critical role of tutors' proficiency in integrating technology into their pedagogical practices for fostering responsible assessment strategies that hold students accountable and promote ethical assessment practices. Furthermore, the analysis demonstrates a strong influence of DA-TPK on continuous assessment (CA), accounting for 43.4% of the variation in this assessment approach. The adjusted R2 value of 0.429 confirms the significant predictive power of DA-TPK in shaping continuous assessment methods that monitor student progress and provide timely feedback. Additionally, DA-TPK shows a moderate but still substantial influence on authentic assessment (AA), explaining 30.8% of the variation, as reflected in the R2 value of 0.308 and the adjusted R2 value of 0.302. These findings underscore the critical importance of developing and enhancing tutors' DA-TPK to support the implementation of effective and comprehensive assessment strategies in educational settings. Educators who possess a strong grasp of integrating technology into their pedagogical practices are better equipped to design and implement authentic, continuous, and responsible assessment approaches that align with the evolving digital landscape of education. The emphasis on the significant impact of DA-TPK on these assessment practices highlights the need for targeted professional development and training programmes to equip tutors with the necessary skills and knowledge to optimize assessment processes and enhance student learning outcomes.

Discussion

The current study's findings align with the broader research landscape that emphasizes the pivotal role of educators in shaping assessment practices, particularly in the context of assessment for learning. The study's focus on

DA-PK and its impact on various assessment approaches resonates with the existing literature that underscores the importance of tutors' proficiency in digital analysis of the R2 and adjusted R2 values in the current study provides valuable insights into the influence of DA-PK on different assessment approaches, highlighting its significant impact on automated assessment (AUA) and continuous assessment (CA).

The findings from the current study, where DA-PK explains a substantial proportion of the variation in AUA and CA, aligns with the principles outlined in the literature regarding the integration of technology in assessment practices. The emphasis on the critical role of tutors' digital assessment-related pedagogical competencies in enhancing assessment strategies and supporting student learning outcomes is consistent with the broader narrative that underscores the importance of educators' proficiency in leveraging technology for pedagogical purposes (Farazouli et al., 2023; Zhang and Wang, 2021).

Moreover, the current study's results regarding the influence of DA-PCK on continuous assessment (CA) and automated assessment (AUA) further reinforce the significance of educators' proficiency in digital assessment pedagogy in shaping assessment practices. The substantial variation explained by DA-PCK in continuous assessment and the notable impact on automated assessment underscore the critical role of educators in streamlining assessment processes and enhancing feedback mechanisms through digital technologies.

In comparison, the findings related to DA-TPK align with the broader discourse on the transformative potential of technology in assessment practices. The strong influence of DA-TPK on responsible assessment (RA) and its substantial impact on continuous assessment (CA) resonate with the principles of authentic, accessible, and automated assessments highlighted in the literature (Johnson et al., 2022). The emphasis on enhancing educators' proficiency in DA-TPK to optimize assessment practices and support student learning outcomes is in line with the overarching goal of leveraging technology to enhance educational outcomes in the digital age.

Overall, the current study's findings align with and contribute to the existing body of research that underscores the critical role of educators in leveraging digital assessment practices to enhance student learning experiences and promote effective assessment strategies. The study's emphasis on the importance of developing tutors' digital assessment-related pedagogical competencies aligns with the broader narrative on the transformative potential of technology in education and underscores the need for ongoing support and solutions to address the challenges faced by educators in implementing digital assessment practices effectively.

Actual Conceptual Framework

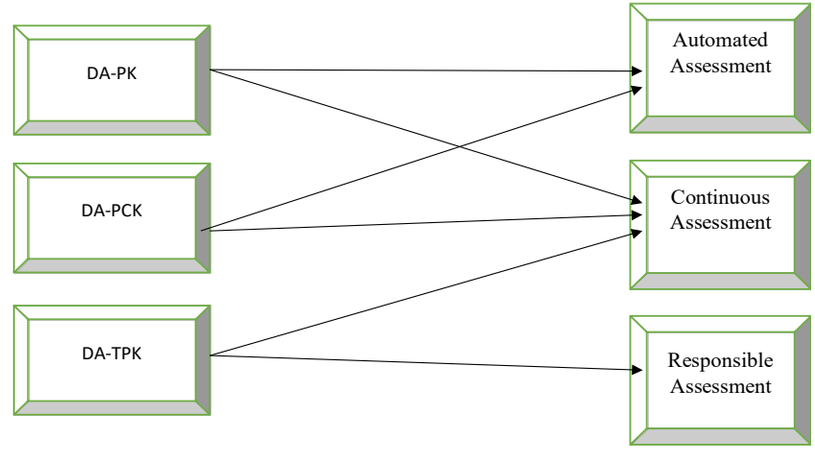

Figure 5

Actual Framework

The final model derived from the comprehensive analysis presents a compelling narrative on the multifaceted influence of tutors' digital assessment-related knowledge on various assessment approaches. The findings reveal a consistent and significant impact of all three independent variables - Digital Assessment Pedagogical Knowledge (DA-PK), Digital Assessment Pedagogical Content Knowledge (DA-PCK), and Digital Assessment Technological Pedagogical Knowledge (DA-TPK) - on Continuous Assessment (CA). This alignment underscores the critical role of educators' diverse competencies in shaping and optimizing Continuous Assessment practices, emphasizing the essential constructive interaction between pedagogical expertise, content knowledge, and technological proficiency in fostering effective assessment strategies that support ongoing student learning and growth. The strong influence of DA-PK on Automated Assessment (AUA) and Continuous Assessment (CA) highlights the pivotal importance of tutors' proficiency in digital assessment pedagogy. Educators who possess a robust understanding of digital assessment pedagogy are better equipped to leverage technology-enabled assessment methods that enhance the efficiency, timeliness, and continuity of the evaluation process, supporting student learning and growth. Similarly, the exceptional impact

of DA-PCK on Continuous Assessment (CA) and Automated Assessment (AUA) emphasizes the significance of integrating technology, pedagogy, and subject matter expertise in designing assessment strategies that effectively evaluate student learning and provide meaningful feedback.

Furthermore, the remarkable influence of DA-TPK on Responsible Assessment (RA) and Continuous Assessment (CA) underscores the critical role of tutors' proficiency in leveraging digital technologies for pedagogical purposes in fostering responsible, ethical, and accountable assessment practices. This finding highlights the importance of educators developing the necessary technological and pedagogical knowledge and skills to optimize assessment processes that promote transparency, fairness, and student-centred learning in the digital age. The final model encapsulates a nuanced understanding of how educators' digital assessment-related knowledge influences various assessment approaches, emphasizing the interconnectedness of pedagogy, content expertise, and technology in shaping assessment practices that promote student engagement, learning outcomes, and educational excellence. This comprehensive framework underscores the imperative for targeted professional development initiatives and training programmes to empower educators with the multifaceted competencies needed to optimize assessment strategies and support student success in the dynamic digital learning environment.

Implication of the Study

The research findings suggest that tutors' proficiency in digital assessment pedagogy, specifically DA-PCK and DA-TPK, play a crucial role in shaping assessment practices. The results indicate that DA-PCK has a strong influence on automated and continuous assessments, explaining a substantial proportion of the variation in these assessment variables. Similarly, DA-TPK shows a significant impact on responsible, continuous, and authentic assessments. These findings have several implications for educational institutions and professional development programmes. First, they highlight the need for targeted professional development and training programmes to equip tutors with the necessary DA-PK. By enhancing tutors' proficiency in digital assessment pedagogy, educational institutions can optimize assessment practices, promote continuous improvement in student learning, and adapt to the evolving landscape of education in the digital age.

Moreover, the emphasis on continuous and automated assessment practices underscores the importance of educators prioritizing digital assessment skills to ensure the effectiveness and efficiency of assessment processes.

By leveraging the power of digital technologies in assessment design, educators can create assessments that are more authentic, accessible, and responsive to student needs. Overall, the research findings underscore the critical role of educators' DA-PCK and TPK in driving effective assessment strategies. By investing in professional development programmes that enhance tutors' digital assessment skills, educational institutions can improve educational outcomes, support student success, and meet the demands of the digital age in education.

Recommendations

Based on the findings of this study, several actionable recommendations are proposed to enhance digital assessment practices in Ghanaian colleges of education. First, educational institutions such as the Ghana Education Service (GES) and the Directorate of Colleges of Education should provide targeted professional development and training programmes. These initiatives should focus on strengthening tutors' DA-PCK and DA-TPK, thereby equipping them with the competencies needed to design and implement effective digital assessments.

Second, college tutors themselves should prioritize the development of digital assessment skills. Embracing digital technologies in assessment design will allow tutors to create more authentic, accessible, and student-responsive assessment strategies that align with 21st-century educational goals. Third, GES should promote the use of continuous and automated assessment practices across institutions. By doing so, educational leaders can foster a culture of ongoing learning and feedback that supports student progress and adapts to the evolving digital landscape.

Finally, teacher education programmes should integrate digital assessment pedagogy into their curricula. Doing so will ensure that pre-service tutors graduate with the requisite knowledge and skills to implement effective digital assessments from the outset of their careers. Collectively, these recommendations aim to support the transformation of assessment practices in Ghana's teacher education sector, ensuring their alignment with contemporary digital learning environments.

Conclusion

The study has provided valuable insights into the influence of tutors' digital assessment technological pedagogical knowledge on the implementation and effectiveness of various assessment approaches in educational settings. The findings indicate that a strong understanding and proficiency in utilizing digital technologies for assessment purposes, as represented

by DA-TPK, significantly impacts responsible assessment practices. This underscores the importance of equipping educators with the necessary digital assessment pedagogical knowledge to enhance assessment practices and support student learning. Moving forward, targeted professional development and training programmes should be considered to further enhance tutors' digital assessment skills and promote authentic, continuous, and responsible assessment practices in educational settings. The study contributes to the existing literature by highlighting the critical role of digital assessment pedagogical knowledge in shaping effective assessment strategies and improving student outcomes.

Data Availability Statements

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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