frontiers | Frontiers in Education

TYPE Original Research
PUBLISHED 25 August 2025
DOI 10.3389/feduc.2025.1642266

Check for updates

OPEN ACCESS

EDITED BY
Agaptus Nwozor,
Bowen University, Nigeria

REVIEWED BY
Jenniffer Sobeida Moreira-Choez,
State University of Milagro, Ecuador
Silvia Gaftandzhieva,
Plovdiv University "Paisii Hilendarski", Bulgaria
Mariuxi Vinueza-Morales,
State University of Milagro, Ecuador

*CORRESPONDENCE
Nusirat Ojuolape Gold
ngold@uj.ac.za;
nusirat.gold@kwasu.edu.ng

RECEIVED 06 June 2025
ACCEPTED 04 August 2025
PUBLISHED 25 August 2025

CITATION
Gold NO, Coovadia H and Mahmood T (2025) Critical thinking development in a Quality Matters-based online learning: student insights from a South African higher education context. *Front. Educ.* 10:1642266. doi: 10.3389/feduc.2025.1642266

COPYRIGHT
© 2025 Gold, Coovadia and Mahmood. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

Critical thinking development in a Quality Matters-based online learning: student insights from a South African higher education context

Nusirat Ojuolape Gold [1,2]*, Husain Coovadia [1] and Tasneem Mahmood [1]

[1]School of Accountancy, College of Business and Economics, University of Johannesburg, Auckland Park Kingsway Campus, Johannesburg, South Africa, [2]Department of Accounting and Finance, Faculty of Management and Social Sciences, Kwara State University, Malete, Nigeria

Introduction: The transition in learning mode from traditional systems to online modes is attracting continuous attention globally. For quality assurance, universities are increasingly adopting online teaching design structured using standards like the "Quality Matters" (QM) rubrics, which are aimed at ensuring continuity and greater accessibility to education. This study investigates students' perception of the impact of online learning designed using QM on critical thinking (CT) development among accounting students at a South African university. Despite the widespread adoption of the QM for online learning platform design, research investigating its specific influence on CT is scarce. Grounded in the constructivist learning theory and the technology acceptance model, the research investigates four key objectives: the impact of QM-aligned online courses on CT, the effectiveness of structured course design in enhancing CT, the role of technology and institutional support in bridging the digital divide, and strategies for optimizing online learning components to foster CT.

Method: Using data gathered through a structured questionnaire, the study employed principal component analysis (PCA) to identify six thematic components that significantly contribute to fostering CT development.

Result: Notably, the significance of engaging resources, course clarity, learner interaction, feedback, and technology accessibility. The findings underscore the importance of well-structured, accessible, and engaging online platforms. They also highlight that technology and institutional support are pivotal to fostering CT development.

Discussion: Although limited to a single institution and relying on self-reported perceptions, the study offers valuable insights into optimizing online course design. Therefore, this study provides recommendations for educators, institutions, and course developers and offers a foundation for future research across diverse educational contexts.

KEYWORDS

critical thinking, online learning, instructional design, Quality Matters, higher education, educational assessment

1 Introduction

The transition in learning modes from traditional to technology-enhanced approaches within the educational sphere has received considerable attention in recent years (Alkhwaldi, 2024; Almaiah et al., 2022; Alshammari and Alkhwaldi, 2025), particularly following the coronavirus disease 2019 (COVID-19) pandemic. This mode of learning has taken myriad forms, such as learning management

systems (LMSs) (Turnbull et al., 2021), massive open online courses (MOOCs) (Herodotou et al., 2022), flipped learning (Chang et al., 2022), problem-based learning (Su et al., 2025), and blended courses (Al Fayyoumi et al., 2025; Alizadeh et al., 2019). As the integration of online learning modes in higher education has become increasingly prevalent among institutions around the globe, universities across South Africa are also making significant strides in utilizing this learning mode. The shift to online learning is particularly meaningful for South Africa due to the country's dual challenge of improving access to education while addressing the deep-rooted socio-economic disparities (Brandon, 2024); hence, paving the way for a future where education is more inclusive and flexible.

As online learning is becoming the center of discourse in enhancing teaching quality and higher-order cognitive skills development, the need for quality assurance in this evolving educational landscape is crucial. Moreover, ensuring that courses delivered through this medium foster critical thinking (CT) has become a priority, particularly for accounting disciplines where analytical reasoning is fundamental to professional competence. As a result, higher education institutions (HEIs) are beginning to implement structured frameworks such as the Quality Matters (QM) rubric, a prominent framework that provides standards for effective online course design (Deuser et al., 2023). Public HEIs in South Africa adopting the online teaching mode are also integrating the QM rubrics in their platform design (Quality Matters, 2025a). The QM framework emphasizes the creation of structured and well-organized learning environments that promote student engagement and reflection, highlighting the importance of aligning course objectives, assessments, and instructional materials to enhance student learning outcomes (Quality Matters, 2023). However, despite the widespread adoption in HEIs in South Africa, the framework's core objective does not explicitly recognize CT development. This raises the vital question of whether its design principles adequately recognize the building of higher-order cognitive skills required in accounting education. Thus, there is an urgent need to assess whether this framework effectively fosters the development of CT skills.

CT is imperative in today's fast-paced, globalized world (Tathahira, 2020), and consequently, extremely important in the accounting field. CT skills are indispensable in the accounting discipline because they are essential for accounting students to analyze information, evaluate arguments, solve complex problems, and make informed decisions pre- and post-graduation (Darwin et al., 2024). Moreover, for online learning, CT skills are crucial in navigating digital resources effectively and independently (Cortázar et al., 2021; Tathahira, 2020). Furthermore, as one of the key aims of university education, CT skills are deemed essential in lifelong learning (Han et al., 2025; Tuononen et al., 2022) and most vital for success in the accounting profession (Lew et al., 2025). Yet, critics argue that the current educational systems often fall short in cultivating these abilities, focusing on rote learning/memorization and standardized assessments, rewarding students for knowledge recall instead of reasoning (Luckin, 2024). This void is extremely disturbing, particularly pertaining to accounting education, where the integration of CT into the curricula is essential in preparing students for the changing needs and the impending reality of the profession. Jääskelä et al. (2018) and Virtanen and Tynjälä (2019) emphasized that these skills are better acquired when integrated within the core course content. Simultaneously, the accounting profession is continuously undergoing significant transformation due to technological advancements (Tettamanzi et al., 2023). As a result, prospective accountants must be equipped with higher-order cognitive skills relevant to making sound business judgments in the increasingly complex landscape. Yet, despite this pressing need, little educational progress has been made (Pincus et al., 2017) in incorporating CT skills into accounting education curricula.

Despite discourse on the importance of CT skills and the wide adoption of the QM framework, existing research has predominantly assessed QM's impact on overall course quality and student satisfaction, leaving a critical gap in understanding how QM-aligned course design specifically supports CT skill development. For instance, existing research such as Alizadeh et al. (2019), Alkramiti and Alsharidah (2022), Barczyk et al. (2017), Brown et al. (2018), Conklin and Barreto (2023), Harkness (2015), Hollowell et al. (2017), Joosten and Cusatis (2019), Kauffman (2015), Kumar et al. (2019), Martin et al. (2016), and Sadaf et al. (2019) only examined the impact of the QM rubric on student learning outcomes, leaving out CT, an important aspect affecting accounting students' employability in the future [International Federation of Accountants, 2021; Papageorgiou, 2023; Rossouw and Steenkamp, 2025; South African Institute of Professional Accountants (SAIPA), 2019]. This gap is even more pronounced in the accounting education context, especially in emerging countries, where digital adoption meets infrastructural and pedagogical challenges.

This study, therefore, fills a significant research void by investigating whether the QM-aligned course structure influences students' ability to critically evaluate information and solve complex problems typical of the accounting discipline. To achieve the research intent, the study focused on accounting students at the University of Johannesburg (UJ), South Africa, as this offers a contextually significant case. UJ's accounting programme houses the largest number of students within South African universities, catering to a diverse student population who must develop CT to navigate complex, technology-driven professional environments. Moreover, South Africa is characterized by a diverse and rapidly evolving technological landscape. Hence, the country's HEIs face unique challenges, such as varying levels of digital literacy and a persistent digital divide (Brandon, 2024).

This study is timely and relevant in response to stakeholders' growing concerns pertaining to the widespread disparities in CT skills amongst students in HEIs (Kleemola et al., 2022; Tuononen et al., 2025). These disparities are mostly linked to domain-specific courses failing to integrate CT into their curricula (Hyytinen et al., 2019). This investigation is also urgent because the country's assiduous digital divide impedes equitable access to quality education (Brandon, 2024). Therefore, exploring the effectiveness of QM-aligned online learning in this environment not only addresses the paucity of CT-focused research in accounting education but also offers practical strategies for optimizing online course design in similar settings across South Africa.

To this end, this study investigates the following objectives:

- Examine how online learning, specifically those developed using the QM rubrics, impacts students' CT skills using a case from a South African university.
- Evaluate the effectiveness of the QM framework in enhancing CT skills by assessing how the structured course design and alignment of learning objectives, assessments, materials, learning activities, and interactions with instructors and other students contribute to the development of CT.
- Assess the impact of technology in fostering CT skills development in students.
- Explore the strategies for optimizing online learning, particularly the resources and materials, and learner engagement standards to improve CT skills.

The study's investigation is hereby guided by the following research questions, which are in line with the stated objectives:

RQ1: How does online learning based on instructional design of QM rubrics influence the CT skills of accounting students in a South African university?

RQ2: Which elements of the QM framework (i.e., structured course design, learning objectives, assessments, engaging materials, and instructor-student interactions) most effectively enhance CT skills?

RQ3: What is the impact of course technology in fostering CT in students?

RQ4: What strategies can be explored to optimize online learning, particularly resources and materials, and learners' engagement standards to strengthen students' CT skills?

In addition, to strengthen the study's theoretical background and assist in the empirical testing, the following hypotheses are formulated:

H1: Online learning based on instructional design of QM rubrics will influence accounting students' CT skills development.

H2: Improved alignment in the QM standards, such as learning objectives, assessments, and course materials, is associated with stronger CT skill enhancement.

H3: Course technology is essential in fostering CT skills development in accounting students.

H4: Optimizing strategies for online learning, particularly the resources and materials, and learners' engagement features, will strengthen students' CT skills acquisition. The study's novelty lies in its hybrid approach to the theoretical lens as it blends the technology acceptance model (TAM) with the constructivist learning theory (CLT) principles backed by empirical analysis. The findings are expected to provide actionable insights to the readership of this journal and educators seeking to enhance student CT through engagement and fostering positive learning outcomes, specifically in the accounting arena. Moreover, by exploring the interplay between educational theory and digital technology, this research highlights the potential for more personalized, interactive, and effective teaching practices in higher education.

By addressing the above objectives, this study seeks to offer an understanding of how online learning, guided by the QM rubrics, supports the development of CT skills among South African accounting students. By doing so, the current study contributes to the existing pool of knowledge and offers several new insights compared to the existing work being done on QM and online learning. Through the assessment of students' perception of the impact of QM-aligned course design on CT skills, the study empirically identifies which components of the QM framework students perceive as most influential in fostering CT. Furthermore, as the study explores strategies in fostering students' engagement in improving their CT skills, it highlights the weaknesses, such as ambiguities in learning objectives and limited engagement activities, that hinder CT development despite adherence to QM rubrics. As a result, the study advances the discourse on excellent teaching in accounting education by providing evidence-based strategies in optimizing QM implementation for deeper CT engagement. The findings of this study therefore inform accounting educators, course developers, and other HEIs in the emerging economies about effective approaches to designing online learning environments that better support CT skills, particularly in relation to learner interaction and engagement. Overall, the findings provide context-sensitive knowledge on bridging technological and pedagogical gaps in CT-focused accounting education and respond to calls for more discipline-specific assessment of online course design.

In the subsequent sections, discussions are presented on the review of related literature, a detailed methodology, presentation of the study findings, and a conclusion with recommendations for educators, course developers, HEIs, and further studies.

2 Literature review

2.1 Conceptual literature

2.1.1 CT: a requirement for the future

CT is universally recognized as a term that reflects higher-level thinking (Tathahira, 2020). Although it remains relatively unstudied (Cortázar et al., 2021), it encompasses dispositions such as confidence, curiosity, and open-mindedness as well as cognitive skills such as interpretation, analysis, evaluation, and explanation (Rossouw and Steenkamp, 2025). It is a crucial skill required in modern education as it enables students to analyze information, evaluate arguments, and make informed decisions (Darwin et al., 2024; Pedraja-Rejas et al., 2024). CT is a model of intelligence essential in addressing real-world problems (Pedraja-Rejas et al., 2024). It involves questioning and evaluating ideas and solutions (OECD, 2019). Within accounting education, it is often viewed as synonymous with solving complex business-related problems (Wolcott and Sargent, 2021). In the context of online learning, it is crucial for navigating digital resources effectively (Cortázar et al., 2021; Tathahira, 2020), and it is also considered a key aim of university education and essential for lifelong learning (Tuononen et al., 2022).

CT, alongside creativity, communication, and collaboration, is dubbed the 4Cs (Lamri et al., 2018) and is regarded as a core skill crucial for creating resilience against changes in the labor market (European Commission, 2016). They are also deemed necessary skills to successfully enter the workforce (OECD, 2019). As a result, it is important that educational institutions shift focus from memorization to fostering independent thinking and problem-solving abilities (Luckin, 2024). The World Economic

Forum (WEF), in its 2022 report, highlighted CT among the top 10 skills needed in 2025 (World Economic Forum, 2022), while the Organization for Economic Co-operation and Development (OECD, 2019) highlighted it as one of the key cognitive skills required for future education. Based on these opinions, CT can be viewed as a multifaceted process essential in analyzing, evaluating, interpreting, and understanding information within various contexts. It can furthermore be referred to as a cognitive process that fosters the ability to reflect and reason logically and coherently, assessing and viewing a difficult task from different perspectives to find an optimal solution to complex problems. Therefore, individuals with strong CT skills are likely to be more self-sufficient and less dependent on the state's social spending.

2.1.2 Strategies for fostering CT online

In the opinion of Cortázar et al. (2021), HEIs are expected to contribute to the development of their students' CT skills. The expectation is for them to groom their students from the foundational years on "how to think" rather than "what to think" (Velez and Power, 2020). This implies students ought to be trained on how to think through the development of CT skills right from their first year at university. Presumably, the first-year courses are expected to expose students to CT by making it explicit and having them reflect on their learning processes. Through this strategy, students will most likely be successful in their university studies and have more time to practice and develop their CT skills before graduating and joining the workforce.

Numerous strategies have been identified as effective in promoting CT in online learning environments. Braun (2004) highlighted three approaches for fostering CT in a business curriculum by including problem-based learning involving case studies, live or applied projects; course-content embedded learning comprising discussions, debates, guided questioning, or scaffolding; and an element underlying other pedagogies. Cortázar et al. (2021) examined strategies to improve CT in online learning platforms, focusing on first-year undergraduate students in engineering. The author compared two groups (control and experimental group) using project-based learning (PBL) for both, but the experimental group was given socially shared regulation scaffolding. It was determined from these pre- and post-tests that online PBL improved CT, with greater gains having been made in the experimental group. According to the study, while PBL can foster CT, socially shared regulation, scaffolding, and feedback are also of great importance. Su et al. (2025) similarly reported that PBL is significantly more effective than traditional teaching methods in enhancing CT skills among medical students. Jaswal and Behera (2024) argued that blended learning fosters CT, especially as it encourages collaboration, task regulation, and knowledge mediation in student-centered environments. It was further highlighted that blended learning offers students the opportunity to engage in autonomous learning strategies that tend to enable them to solve problems along with their group members. Furthermore, they noted that reflective and meta-cognitive thinking, self-regulation, decision making, problem-solving, and disciplinary forms of thinking that students are exposed to in blended learning offer the students mental clarity. Feedback and self-reflection through peer review assessment are another strategy for fostering CT (Jaswal and Behera, 2024). It is further argued that peer review involving idea-sharing through synchronous and asynchronous communication, critical evaluation of information sources, investigative and analytical skills, text outlining, summarizing, highlighting, and reflective abilities developed on the online learning platform via peer review helped students evaluate and improve each other's work, consequently fostering CT.

Learning through asynchronous discussion forums is another strategy for fostering CT, as identified by Afify (2019), Al-Husban (2020), Foo and Quek (2019), Giacumo and Savenye (2020), and Tathahira (2020). These authors noted that asynchronous discussion forums allow students to reflect on their thoughts and engage in meaningful discussions, which are found to be an essential element in developing CT skills (Foo and Quek, 2019). Additionally, Tathahira (2020) added that asynchronous online discussions offer important benefits, such as presenting opportunities to students to build their interests and reach a higher level of knowledge. Ernita et al. (2024) also mentioned that self-regulated learning through virtual laboratories is a vital mechanism for enhancing CT skills. According to extant debates, this approach encourages students to apply CT by solving real-world problems, thereby enhancing their analytical skills.

2.1.3 Overview of the quality matters (QM) rubrics and standards

QM is a non-profit organization that has gained national recognition and acknowledgment (Conklin and Barreto, 2023; Deuser et al., 2023) by having developed a system that consists of processes for the design and review of online or hybrid (i.e., partially online) courses based on a rubric that comprises eight (8) overarching general review standards. According to Quality Matters (2023), the general standard (GS) 1 focuses on the "Course Overview and Introduction." This standard provides clarity in the course's overall design, establishing expectations for students (e.g., prerequisite knowledge, technology requirements, and computer skills) and providing guidance to assist students in successfully completing the course. GS 2, which focuses on "Learning Objectives-Competencies," establishes a standard for clear, specific, measurable, level-appropriate learning objectives (i.e., what students should be able to do upon completion of the course). GS 3 concentrates on "Assessment and Measurement," which addresses the need for course assessments to evaluate students' progress and achievement of stated learning objectives. GS 4 targets "Instructional Materials" that support the inclusion of instructional materials that enable students to achieve the learning objectives. GS 5 focuses on "Learning Activities and Learner Interaction," which addresses the need to facilitate and support student engagement and interaction with the instructor, the materials, and fellow classmates. GS 6 centers on "Course Technology," which includes the need for course technologies to support student achievement of the learning objectives. GS 7 targets "Learner Support" and ensures that the course facilitates student access to available support (including academic, technical, accessibility, and student services). GS 8 focuses on "Accessibility

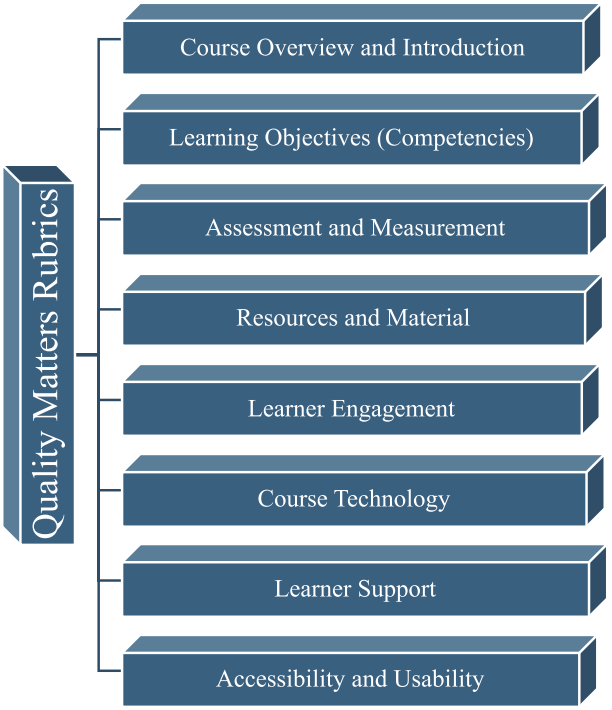


FIGURE 1
The eight general standards required by the Quality matters (QM) rubrics for the design of an online platform. Source: Author's draft.

and Usability," which addresses ways to reflect on the commitment of making the course and its components more accessible and functional for all students. The eight QM general standards (summarized in Figure 1) provide a framework for applying best practices in online course design with the goal of facilitating student success.

The QM process provides an institutional toolset and processes necessary to meet quality expectations in areas of online course design, student learning, improved instruction, assessment, and feedback loops, as well as professional development (Conklin and Barreto, 2023). Institutions willing to incorporate online teaching and learning into their courses can submit these for official peer review to the QM organization. If the standards applied to the course review are sufficiently met, it results in certification of the course by the QM organization (Deuser et al., 2023).

The quality of the QM framework has been examined over time by comparing it to a set of standards proposed by the Council for Higher Education Accreditation (CHEA) and its eight regional accrediting agencies, including the Middle States Commission on Higher Education and the Southern Association of Colleges and Schools (Deuser et al., 2023). It has therefore been accredited to be congruent with the published accreditation standards for online education (Conklin and Barreto, 2023; Deuser et al., 2023; Sadaf et al., 2019). The QM framework emphasizes the importance of aligning course objectives, assessments, and materials to enhance student learning outcomes (Quality Matters, 2025b). These frameworks are designed to mitigate some of the challenges often inherent in online learning by providing structured and well-organized learning environments that promote student engagement and reflection.

2.2 Theoretical review

2.2.1 Technology acceptance model (TAM) link to CT development in online learning

The TAM is generally known to explain how users adopt technology based on two key variables (see Figure 2): perceived usefulness (belief that a system enhances performance) and perceived ease of use (belief that it requires minimal effort), which shape attitudes, intention, and actual use (Davis et al., 1989; Han et al., 2025). Within educational contexts, the TAM highlights that technology must not only function seamlessly but also demonstrably enrich learning experiences to encourage user adoption and engagement (Mathur et al., 2024). The TAM's perceived usefulness, perceived ease of use, intention to use, and actual usage remain the core components making up a comprehensive causal sequence of cognition, affection, and behavior (Han et al., 2025). Collectively, the TAM suggests that the advanced sophistication of technology is observed to facilitate its perceived usefulness, which leads to higher acceptance among users and subsequently determines learners' performance. Therefore, examining the link between the TAM and CT skills development in online learning is necessary.

This study defines "perceived usefulness" as the degree to which student believes that using an online learning forum, along with the associated tools, can enhance their knowledge and consequently foster CT skills. "Perceived ease of use" refers to the degree to which the student believes that using the online learning forum and its tools will minimize physical and mental effort, thereby enabling critical thinking. Tools that are intuitive, accessible, and well-aligned with course design enhance motivation to engage critically, supporting a deeper cognitive processing.

The TAM has also been used in numerous contexts and technology-related studies, as in the case of learning foreign languages (Dehghani and Mashhadi, 2024; Han et al., 2025), online learning (Mathur et al., 2024; Sadaf et al., 2019), digital technologies (Alshammari and Alkhwaldi, 2025), inquiry-based teaching pedagogy (Hu et al., 2024), human–computer interaction (Al-Sayid and Kirkil, 2025), hospitality education (Lefrid et al., 2023), virtual classrooms (Kemp et al., 2024), learning management systems (LMSs) (Al-Mamary et al., 2023), and mobile-learning (Pedraja-Rejas et al., 2024; Suliman et al., 2023). By integrating the TAM, this study captures how the perceived usability of QM-aligned online courses supports students' critical engagement. Accordingly, it is hypothesized that:

H1a: Students who perceive online course tools as useful demonstrate stronger critical engagement.

H1b: Students who find the digital course tools employed in online learning easy to use exhibit higher engagement, fostering CT development.

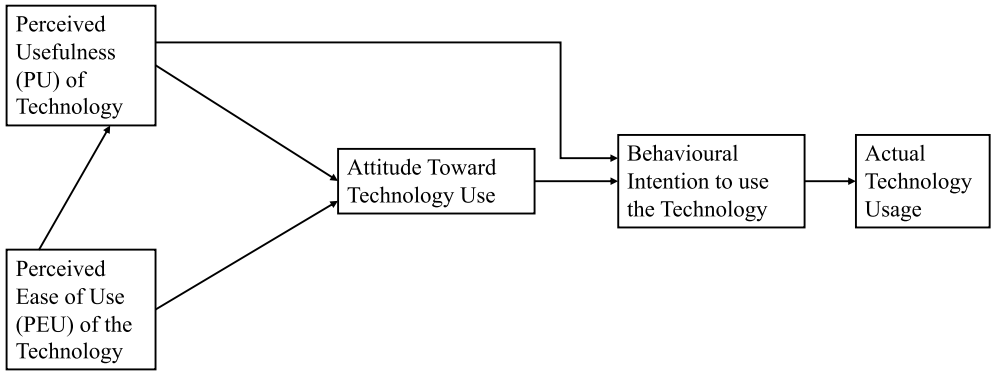


FIGURE 2
Technology acceptance model (TAM) adapted from Davis et al. (1989).

2.2.2 Constructivist learning theory (CLT) link to CT

The constructivist learning theory (CLT) refers to the system of learning that offers learners the ability to "construct" their own knowledge and skills through social activity and meaningful interactions (Stanley and Marsden, 2012). The theory posits that learners actively build knowledge through experience, reflection, and meaningful social interaction rather than passively receiving information (Bada and Olusegun, 2015; Liu et al., 2025). The CLT emphasizes the importance of focusing on experiential learning instead of the conventional lecture approach (Vijayakumar Bharathi and Pande, 2024). The CLT proponents emphasize that experiential, inquiry-based, and collaborative learning, where students integrate new information with prior knowledge via assimilation and accommodation, bring about deeper understanding and revised perspectives (Musundwa, 2024).

Therefore, the CLT underpins the development of CT by encouraging curiosity, investigation, and the ability to establish connections between concepts (Feyzi Behnagh and Yasrebi, 2020; Turakhia et al., 2024). In the field of accounting education, researchers often debate whether the CLT principles with a focus on student-centered learning emphasize the relevance of prior knowledge, collaborative environments, flexible assessment, and inclusivity as vital resources for fostering meaningful engagement and deeper comprehension (Jayasinghe, 2021; Musundwa, 2024). More importantly, the approach positions teachers as facilitators, designing environments and tasks that enable students to independently construct and transform knowledge, rather than merely transmitting information (Liu et al., 2025). The online learning environment typically offers diverse tools and resources that support personalized learning and provide immediate feedback. This feature aligns easily with constructivist pedagogical principles (Liu et al., 2025). As a result, it is argued that the CLT offers a pedagogical perspective, emphasizing that learners actively construct knowledge through interaction, reflection, and experience. Thus, this theory supports the notion that well-structured online environments, as advocated by the QM rubric, can promote CT skills by facilitating active and meaningful learning experiences. Therefore, we hypothesize that:

H1c: Online learning aligned with QM instructional design encourages deep thinking, consequently fostering CT development.

The TAM and the CLT combined offer a comprehensive lens for analyzing how instructional design quality and technological usability jointly influence the development of CT skills for students enrolled in online accounting education programmes.

2.3 Empirical literature

2.3.1 Online learning and QM rubrics

Literature already exists on QM-aligned online learning, and the relationship between both has been the subject of extensive discussions across many domains. However, how this impacts students' CT, a vital competency in accounting education, remains underexplored. A consistent theme across many studies is that the QM-aligned framework strengthens learner engagement, clarity, and satisfaction, yet how these translate into higher-order cognitive skills remains a gray area. For instance, some authors consistently found that interactive learning activities and well-structured course materials based on the QM rubrics enhance student engagement and satisfaction (Brown et al., 2018; Deuser et al., 2023; Martin et al., 2016). These authors stressed that clear and measurable learning objectives, along with access to appropriate technology, create a conducive environment that fosters deeper engagement, which is a crucial precursor to CT.

Similarly, investigations into blended and online courses in diverse contexts, such as English language learning (Alizadeh et al., 2019) and mathematics education (Alkramiti and Alsharidah, 2022), reveal that the QM-based design offers flexibility and better articulated content that supports knowledge retention and application.

Evaluating the effectiveness of a blended learning course, Alizadeh et al. (2019) examined for Japanese English learners, while Alkramiti and Alsharidah (2022) focused on mathematics education. Their findings both revealed that the QM-aligned design offers flexibility and better-structured content that supports knowledge retention and

application. Meanwhile, the research stressed that technological challenges and the need for improved faculty support linger on, underscoring that design quality alone is insufficient without adequate technical infrastructure and instructor training. Collectively, these shreds of evidence show that while the QM frameworks contribute to the structural and experiential quality of online learning, notable gaps remain in the understanding of their direct role in fostering CT, especially within discipline-specific settings such as accounting, where analytical and evaluative reasoning are vital inputs for students' future employability.

2.3.2 Online learning and CT

CT is an essential skill required of any accounting professional, as the profession traditionally involves solving complex problems, ones that generally would require making informed decisions. As this skill is an essential attribute for business education (Calma and Davies, 2021), including the accounting profession, preparing future accountants to think critically becomes paramount. Meanwhile, as universities are the primary place where most of these professionals are first mentored, it is imperative to ensure the students are equipped with the requisite skills and knowledge that will make them employable. To ensure the employability of these future professionals, universities have begun integrating different strategies, such as online learning and blended learning, into their teaching curriculums as approaches to foster CT in students. The online learning environment has been argued to offer unique opportunities for developing these skills, specifically, through asynchronous discussions that facilitate reflective thinking and problem-based learning tasks that enhance analytical skills (Afify, 2019; Al-Husban, 2020; Cortázar et al., 2021; Ernita et al., 2024; Foo and Quek, 2019; Giacumo and Savenye, 2020; Tathahira, 2020).

Researchers have also tried investigating how to ascertain the effectiveness of online learning in enhancing students' CT skills. For instance, Rossouw and Steenkamp (2025) focused on South African accounting students and found that active learning interventions in online courses improved students' capacity to analyze and evaluate accounting concepts critically, driven by increased engagement and collaborative learning. In Mexico, Gonzalez-Cacho and Abbas (2022) recorded similar findings confirming interactivity and active collaborative learning as contributory to CT development. Furthermore, Ospankulova et al. (2025), who focused on science students, demonstrated that the PBL strengthens CT by promoting motivation, collaboration, and application of knowledge to practical scenarios. Similar findings were recorded by Cortázar et al. (2021) and Orhan (2024) in their different studies. In addition, Vijayakumar Bharathi and Pande (2024) reported that online collaborative learning environments (OCLE) grounded in constructivist learning approaches significantly mediate the impact of certain constructivist tenets, such as optimizing known knowledge, experiential learning, and adaptive cognition toward developing creative thinking and cognitive thinking skills. Together, these studies highlighted that online learning, when effectively designed to encourage active engagement, collaboration, and reflective practice, provides a conducive environment for CT development in accounting education programmes (Figure 3).

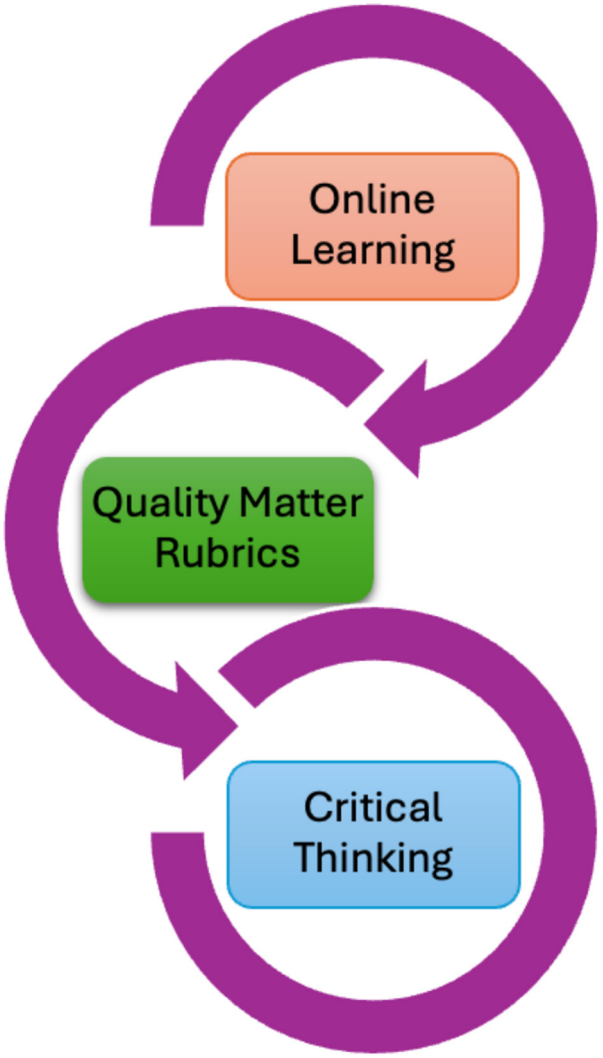


FIGURE 3
Research framework connecting online learning, QM, and CT. Source: Author's draft.

3 Materials and methods

3.1 Research design

This study employed a quantitative research approach to investigate the impact of online learning, using the QM rubrics, on the CT skills of undergraduate students enrolled in the BCom Accounting programme at a South African university. This design enabled the collection of data to determine whether the QM rubrics influenced the development of CT skills of the BCom accounting undergraduate students.

3.2 Population and study area description

The study population consisted of all second-year undergraduate accounting students (population = 120) enrolled in the BCom Accounting programme at the University of Johannesburg (UJ). The second-year students were purposively chosen because they represented a vital stage in the CT skills development within the accounting programme. At this level, students have moved beyond the foundational first-year modules and are beginning to take intermediate and discipline-specific courses that involve higher-order cognitive, analytical, and evaluative skills. Moreover, the belief exists that students have acquired sufficient exposure to online learning environments. This allows them to provide informed opinions on course design, technological tools, and engagement strategies. In addition, selecting this cohort reduces any confounding effects associated with the transitional issues typical of first-year students and the advanced specialization of senior-level students, providing a balanced perspective on the influence of the QM-aligned online course learning on CT development. UJ, on the other hand, is a prominent public university located in Johannesburg, the largest city in Gauteng Province, South Africa (see Figure 4). The Accounting Programme at UJ is one of the most valued among all South African institutions, offering a wide range of qualifications at undergraduate and postgraduate levels. The programme is accredited by the South African Institute of Chartered Accountants (SAICA), and its courses are designed to produce not just technically proficient and ethically grounded students, but also critically-minded accounting professionals. UJ's exhortation emphasizes a transformational approach to education, integrating technology and real-world relevance. UJ's approach to teaching and learning, coupled with the appeal from stakeholders such as the International Federation of Accountants (IFAC), SAICA, and the South African Institute of Professional Accountants (SAIPA) to groom students who are "employable and can think critically," underscores the choice of the second-year students [International Federation of Accountants, 2021; Papageorgiou, 2023; Rossouw and Steenkamp, 2025; South African Institute of Professional Accountants (SAIPA), 2019].

3.3 Participants, sample, and instrumentation

The inclusion criteria for participants were as follows: (i) enrolment into the BCom accounting programme which is presented fully online; (ii) participants must be in their second year of the programme during the study period as these students had the first exposure to the QM design; (iii) actively engaged in the online course; and (iv) signed informed consent forms to participate in the study. The exclusion criteria were as follows: (i) students who had not yet completed any QM-aligned online courses; (ii) those who declined to participate; and (iii) submissions with incomplete or invalid responses. These criteria were established to ensure that all participants had direct and relevant exposure to the QM-aligned online learning, enabling an informed assessment of its impact on CT skills development. Hence, the study employed a purposive sampling approach with a survey instrument to gather data. Developing a series of questions (42 in total), the eight general QM standards were incorporated. The students were asked, based on their perception, to rate how the QM-aligned online courses assisted them in developing CT skills. The questions raised focused on the elements of course overview and introduction, learning objectives, assessment and measurements, instructional materials, learning activities and interactions, course technology, learner support, and accessibility and usability (see Figure 1).

The instrument comprised a five-point Likert scale, which was adapted from Deuser et al. (2023) and it consisted of two main sections: First, the focus was placed on demographic information of the respondents, covering consent, respondents' age, gender, prior accounting knowledge at secondary school, prior experience with online learning, and their level of technological experience. The second section consisted of 42 items subdivided into the eight QM standards, with each posing questions to assess whether and the extent to which the students perceived each of the items as enhancing their development of CT skills. The final sample was based on 93 responses, a number deemed sufficient according to krejcie and Stanley (1970). Previous researchers who examined CT in students within the accounting domain are Cloete (2018) and Rossouw and Steenkamp (2025). However, these studies did not employ the QM standards.

3.4 Ethical considerations

The study obtained ethical approval with the ethical code SAREC20230314/08 before conducting the study. Informed consent was also obtained from all participants with clear assurance of confidentiality and anonymity.

4 Results

4.1 Analysis and interpretation of demographic data

This study received a total of 93 responses, accounting for 77.5% of the study population. The median age of respondents falls between 18 and 30 years, with females making up the majority of the sample (55.9%). Approximately 68% of the respondents studied accounting at O-Level, and ~52% had no prior exposure to online learning. Additionally, ~65% of the respondents had knowledge of technology at least at an intermediate level, suggesting they are technology literate.

4.2 Reliability test

Reliability tests were conducted to ensure the validity and reliability of the instruments used. Table 1 presents the results of Cronbach's Alpha, showing high internal consistency across all rubric dimensions. All the values exceeded 0.85, surpassing the commonly accepted threshold of 0.70 (Taber, 2018). This level of reliability supports the stability of the instrument in capturing students' perceptions, confirming its reliability. Comparable results have been reported in studies by Lin et al. (2023) and Simelane-Mnisi (2023), affirming that well-designed



FIGURE 4
Map of the study area (University of Johannesburg, South Africa). Source: https://commons.wikimedia.org/wiki/File:University_of_Johannesburg.jpg#:~:text=Author-,Aurobindo%20Ogra,-Licensing%5Bedit.

online learning instruments offer consistent measurements of students' engagement and CT skills development. These findings, in conjunction with the trends shown by the descriptive analysis, underscore the importance of aligning the course design framework, particularly the resources, the technology, and the learner engagement with practices that foster CT.

4.3 Data analysis

We present the descriptive analysis which shows the percentages of each item response category, mean, and standard deviation, and the overall percentage for each of the constructs representing the eight general standards. To further examine the important features and patterns from the students' responses on the QM standards, a multivariate data analysis using a principal component analysis (PCA) was conducted by transforming the 42 questions into a smaller set of variables called the principal components, which retain the most valuable features from the data. A similar approach was employed in the study of Deuser et al. (2023). All analyses were performed in R Studio (version 4.3.1, 2023). The outcomes from the Kaiser–Meyer–Olkin (KMO = 0.91) indicated sampling adequacy (Kaiser, 1960), and Bartlett's test of sphericity [$\chi^2_{(861)} = 3953.37$, $p < 0.001$] indicated that the data were sufficiently suitable to continue factor analysis.

4.3.1 Descriptive results

Students agreed that the course reflected best practices in instructional design and, as a result, impacted the CT skills, shown in Table 2 on descriptive analysis. The result herein revealed that a high majority of students perceived online learning as supportive of their CT skills development, with 38 out of 42 QM-aligned items receiving over 50% agreement (i.e., agree/strongly agree). Notably, 26 items received particularly strong ratings, ranging between 60% and 84% agreement, indicating widespread recognition of the course's CT-promoting features. Among the eight general standards, standard 8 on Accessibility and Usability emerged as the most positively rated category, with ∼75% of students agreeing or strongly agreeing that this aspect of the course supported their CT skills. This was closely followed by standard 6 on "Course Technology" and standard 1 on "Course Overview and Introduction," each earning 71% positive ratings. These findings suggest students essentially valued well-structured instructional design, resources, and effective technology usage, supporting critical analysis of accounting concepts and CT development. The findings align with Getenet et al. (2024), who demonstrated that well-integrated technology and accessible resource materials significantly enhance learners' engagement and support CT when pedagogically aligned.

Contrary to the above, standard 2 on learning objectives attracted a high neutral response (31.8%), suggesting uncertainty of this standard's role in fostering CT. This corroborates the findings of Nwosu and Vorster (2021), who noted complexities in articulating course objectives as a barrier to cultivating CT in undergraduate accounting students. Meanwhile, standard 5 on "Learner Engagement" received the lowest rating, though still moderately favorable, with 53.3% agreement. This suggests that there is room for improvement in fostering more dynamic interaction within the course. The variability in mean scores between the dimensions underscores the need for pedagogical alignment, supporting Nwosu and Vorster (2021) argument that clear objectives and targeted learning activities are crucial for interpreting engagement with CT benefits.

Despite the overall positive perception, four items fell below the 50% agreement threshold, flagging them as potential weaknesses in the course design. These included: (i) "Assessments align consistently with course activities"; (ii) "Resource materials provide sufficient real-world examples"; (iii) "Learning activities encouraged meaningful interaction with instructor"; and (iv) "Learning activities promoted interaction with other students."

TABLE 1 Reliability test output.

Reliability statistics				
Constructs	**Cronbach's Alpha**	**Cronbach's Alpha based on standardized items**	***N***	**Items included**
Course overview	0.908	0.909	6	CO 3–8
Learning objectives	0.894	0.894	2	LO 2 and 4
Assessment and measurement	0.855	0.857	6	All items
Resources and materials	0.92	0.922	6	Rm 3–8
Learner engagement	0.897	0.898	9	All items
Course technology	0.902	0.904	4	CT 4–7
Learner support	0.903	0.904	5	All items
Accessibility and usability	0.922	0.924	4	Asu 1–3 and 5

Results of the reliability test after some items with excessively high values were removed to prevent redundancy and duplication of items. Source: Author's computation.

Furthermore, while disagreement levels remained low across most standards, the following items had more than 20% of students disagreeing or strongly disagreeing. (i) "Feedback on assessment is constructive"; (ii) "Learning activities encouraged interaction with the instructor"; and "Learning activities promoted peer interaction."

These results indicate that while the course broadly supports the development of CT skills, especially through accessible design and technology integration, interactive learning components, particularly instructor and peer engagement, remain key components for greater enhancement.

Based on the results, the item-level reliability trends further substantiate the QM rubrics' capacity as a measure of CT-supportive learning environments, students' perceptions. Furthermore, differences in agreement trends across items indicate the centrality of student–instructor interaction and institutional support, echoing Terblanche et al. (2023), who documented that fostering interaction is pivotal to bridging the gap between professional CT expectations and accounting education. Triangulating these validate the QM-based course design's capacity to foster CT development, particularly when course technology, resources, and accessibility are effectively aligned, while highlighting areas requiring improvement, like the clarity of learning objectives and the enhancement of learners' engagement (Figure 5).

The results of the PCA on the percentage of variation are presented in Table 3. The singular value decomposition method was used to conduct the principal component analysis. The first principal component (PC) explained 53.14% of the variance from the students' responses, which accounts for the most variation in the data. About 73.37% of the data variance was explained by putting the first six PCs together.

The scree plot shown in Figure 6 orders the eigenvalues, which are numbers that indicate how the data are spread out on the Eigen-vector (PC) from largest to smallest. Based on these results, the first six PCs with eigenvalues >1 were retained.

A "Biplot" (Figure 7) was also plotted to offer further insight into the relationships between the variables and the data structure. The core observation is found in "Dim1" (comprising PC1) that explains 53.1% of the variance, suggesting most responses cluster strongly along Dim1, while "Dim2" (PC2) explains 5.8% of the variance. Both Dims explain around 59% of the total variance. Hence, the outward-pointing arrows (vectors) indicate a strong contribution, and the variables pointing in a similar direction show that the retained components are positively correlated. Overall, this is suggestive of the items (Q1–Q42) being highly interrelated and a good measure of a common underlying construct, i.e., CT skills.

4.3.2 Discussions and interpretation of findings

In order to explore the magnitude and direction of each PC to the original QM questions, the absolute values of the loading scores were examined. The larger the absolute value of the loading, the more important the corresponding question is in influencing the PCs. Table 4 presents the first six PCs and the top 10 absolute loading scores for each PC. The findings derived herein offer nuanced insights into how the QM design influences the CT skills in an online accounting course. Rather than merely listing components and their loadings, an interpretation was provided for each dimension to show the contributions to the CT development and what this means for pedagogy and online platform design.

PC 1 primarily measures the "Resources and Materials" that have large values exhibiting a strong association with the QM rubric standards 4–6. This underscores the core role of well-structured instructional content in enhancing cognitive engagement. The highly loaded items related to knowledge assessment require CT application by students, engaging and interactive resource materials relevant to accounting topics. From the CLT perspective, these elements align with the view that learners actively construct knowledge through meaningful content. Moreover, in line with the TAM, the perceived usefulness and clarity of learning materials enhance users' acceptance and engagement with digital tools. Empirically, this is consistent with prior studies (Alizadeh et al., 2019; Alkramiti and Alsharidah, 2022; and Brown et al., 2018) that emphasize well-structured instructional resources, which significantly influence students' performance. Online learning environments also offer unique opportunities for students to learn in contexts that closely resemble real-world settings (Rossouw and Steenkamp, 2025). These foster a deeper learning and CT skills development (Ospankulova et al., 2025; Vijayakumar Bharathi and

10.3389/feduc.2025.1642266

TABLE 2 Mean, standard deviation, and percentage of response options for the extent QM Rubrics' foster CT.

Standard 1: Course overview and introduction	*N*	Mean	Std. Dev.	Percentages				
				SA (%)	**A (%)**	**N (%)**	**D (%)**	**SD (%)**
1. Guidance on course components	93	3.81	1.014	29	34.4	26.9	7.5	2.2
2. Clarity of learning objectives	93	4.28	0.839	47.3	37.6	11.8	2.2	1.1
3. Minimum requirements for course completion	93	4.04	0.977	39.8	32.3	22.6	3.2	2.2
4. Minimum technical skills expected	93	3.81	1.014	26.9	39.8	23.7	6.5	3.2
5. Online discussion forum structure	93	3.86	1.006	29	39.8	22.6	5.4	3.2
6. Email communication	93	3.9	0.968	30.1	39.8	22.6	5.4	2.2
Grand percentage				**33.7**	**37.3**	**21.7**	**5.03**	**2.35**
Standard 2: learning objectives								
7. Instructions on meeting learning objectives	93	3.68	1.034	24.7	32.3	32.3	7.5	3.2
8. Learning objectives impact	93	3.6	1.054	22.6	32.3	31.2	10.8	3.2
Grand percentage				**23.7**	**32.3**	**31.8**	**9.15**	**3.20**
Standard 3: assessment and measurement								
9. Clarity of assessment methods	93	3.72	0.96	19.4	46.2	24.7	6.5	3.2
10. Alignment between course assessments activities	93	3.41	1.096	16.1	33.3	32.3	11.8	6.5
11. Alignment between assessments and additional learning resources	93	3.59	1.086	21.5	35.5	29	8.6	5.4
12. Clarity of grading policy	93	3.8	0.962	24.7	40.9	25.8	6.5	2.2
13. Time allotted for assessments	93	3.71	1.059	23.7	40.9	22.6	8.6	4.3
14. Feedback provided on assessments	93	3.33	1.297	22.6	28	19.4	20.4	9.7
Grand percentage				**21.3**	**37.5**	**25.6**	**10.4**	**5.22**
Standard 4: resources and materials								
15. Course contents are current	93	4.02	0.859	29	51.6	12.9	5.4	1.1
16. Assignments given fostered CT	93	3.56	1.037	17.2	40.9	26.9	10.8	4.3
17. Exams adequately assess student knowledge	93	3.49	1.119	18.3	36.6	29	8.6	7.5
18. Engaging learning materials	93	3.42	1.219	20.4	32.3	25.8	11.8	9.7
19. Clarity of course materials about accounting concepts	93	3.72	1.097	24.7	40.9	22.6	5.4	6.5
20. Learning materials provide sufficient real-world examples	93	3.16	1.182	12.9	29	30.1	17.2	10.8
Grand percentage				**20.4**	**38.6**	**24.6**	**9.87**	**6.65**
Standard 5: learner engagement								
21. Learning activities encouraged active engagement	93	3.61	0.933	18.3	36.6	34.4	9.7	1.1
22. Learning activities encouraged meaningful interaction with my instructor.	93	2.88	1.15	10.8	15.1	38.7	22.6	12.9
23. Learning activities promoted interaction with peers	93	2.98	1.132	8.6	25.8	31.2	23.7	10.8
24. Instructors responded to emails promptly	93	3.94	1.041	35.5	35.5	18.3	8.6	2.2

(Continued)

TABLE 2 (Continued)

Standard 1: Course overview and introduction	*N*	Mean	Std. Dev.	Percentages				
25. Instructors were available for consultation	93	4.06	0.942	40.9	30.1	24.7	3.2	1.1
26. Easy Instructor interaction	93	3.61	1.152	26.9	29	28	10.8	5.4
27. Constructive feedback on assignments	93	3.37	1.232	19.4	33.3	20.4	18.3	8.6
28. Timely feedback on assignments	93	3.56	1.146	23.7	32.3	25.8	12.9	5.4
29. Opportunities to interact with peers	93	3.68	1.153	30.1	28	25.8	11.8	4.3
Grand percentage				**23.8**	**29.5**	**27.5**	**13.5**	**5.76**
Standard 6: course technology								
30. Appropriate technologies were used	93	3.81	1.2	36.6	29	18.3	10.8	5.4
31. Technologies were readily available	93	4.08	0.992	40.9	35.5	16.1	5.4	2.2
32. Course components were easily downloadable	93	4.02	1.083	43	30.1	15.1	9.7	2.2
33. Appropriate media were employed	93	3.99	1.005	37.6	34.4	18.3	8.6	1.1
Grand percentage				**39.5**	**32.3**	**16.9**	**8.63**	**2.73**
Standard 7: learner support								
34. Clarity about technical support services available	93	3.73	1.054	24.7	39.8	23.7	7.5	4.3
35. Technical support teams responded promptly	93	3.81	1.003	26.9	39.8	22.6	8.6	2.2
36. Student assistance and other support teams	93	4.16	0.936	44.1	35.5	14	5.4	1.1
37. Availability of academic support services	93	3.74	1.102	28	36.6	21.5	9.7	4.3
38. Easy access to instructors for enquiries	93	4.03	1.078	43	30.1	17.2	6.5	3.2
Grand percentage				**33.3**	**36.4**	**19.8**	**7.54**	**3.02**
Standard 8: accessibility and usability								
39. Ease of course navigation	93	4.02	0.989	37.6	36.6	18.3	5.4	2.2
40. Consistency of weekly activities templates	93	4.09	1.08	46.2	29	15.1	6.5	3.2
41. Course design requires minimal effort to navigate	93	3.95	1.126	39.8	30.1	20.4	4.3	5.4
42. Resources and materials were easily accessible	93	4.17	0.916	44.1	35.5	15.1	4.3	1.1
Grand percentage				**41.9**	**32.8**	**17.2**	**5.13**	**2.98**
Overall percentage				**29.7**	**34.6**	**23.1**	**8.7**	**4.0**

Descriptive data output showing. N, number of observation; mean, average response recorded; Std. Dev., standard deviation of the response recorded; SA, Strongly Agree(5); A, Agree(4); N, Neutral(3); D, Disagree(2); and SD, Strongly Disagree(1). Source: Author's computation.

Pande, 2024; Wolcott and Sargent, 2021). Thus, enhancing their ability to apply and understand knowledge (Alpala et al., 2022; Liu et al., 2025). This finding has implications for educators and course instructors to ensure that course materials not only align with learning objectives as instructional design requires, but also should be crafted in a manner so as to provoke analytical engagement.

PC 2 highlights "Interaction and Institutional Support," emphasizing the value of social interaction of the constructivist view that knowledge is co-created through collaboration. These findings underscore the critical role of collaborative learning environments and technical support structures in enhancing the student learning experience. The TAM in this dimension suggests

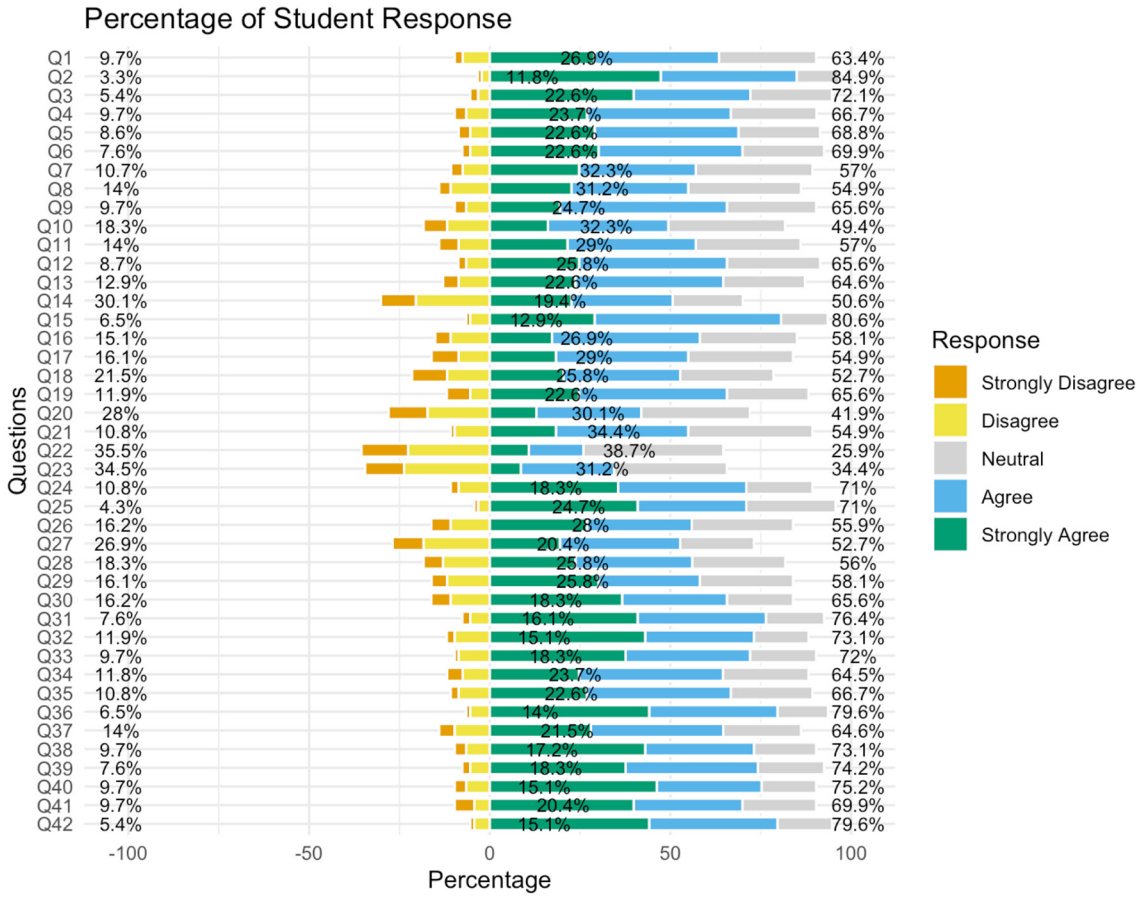


FIGURE 5
Percentage of student responses. The percentage of student responses for each question in the survey is shown in accordance with the Likert scale, ranging from strongly disagree to strongly agree. The percentages shown to the far right are the aggregate response for strongly agree and agree, to the far left are the aggregates for strongly disagree and disagree, while the neutral percent is found at the center. Source: Author's computation.

that facilitating conditions (e.g., support systems provided) strongly influence behavioral intention to use online learning. Research by Baber (2020), Sun et al. (2025), Vijayakumar Bharathi and Pande (2024), and Wolcott and Sargent (2021) echoes these findings, highlighting the interaction between as a determinant of student satisfaction and CT. While the relatively lower student ratings in this domain suggest an underutilized opportunity, the implication is that institutions and instructors need to enhance the measures employed for communicating in online learning platforms and to provide proactive support channels that promote both academic and technical engagement.

PC 3 centers around "Course Overview and Introduction," reflecting students' need for clearer navigation and learning pathways, which directly impacts their autonomy and confidence in engaging critically. While these design elements may appear administrative, the foundation for cognitive presence is positioned as a key domain in Community of Inquiry (CoI) frameworks that align with CT development. The finding corroborates the argument that the presence of a clear course structure supports learners in developing strong mental models and their own understanding of concepts, and their meaning according to the context, thereby fostering self-directed learning, a core component of the constructivist pedagogy (Adigun et al., 2025). From the TAM's perspective, clarity in course design enhances perceived ease of use, thus encouraging adoption thereof. Studies such as those by Alizadeh et al. (2019), Alkramiti and Alsharidah (2022), and Conklin and Barreto (2023) highlight that well-structured course

TABLE 3 Eigenvalues, variance explained, and cumulative variance for survey response.

CT PCA Eigen values			
Component	**Eigenvalue**	**Variance explained (%)**	**Cumulative variance (%)**
PC1	22.32	53.14	53.14
PC2	2.46	5.85	58.99
PC3	2.01	4.8	63.78
PC4	1.59	3.78	67.56
PC5	1.28	3.04	70.6
PC6	1.16	2.76	73.37

Table for eigenvalues from PCA computation. Source: Author's computation.

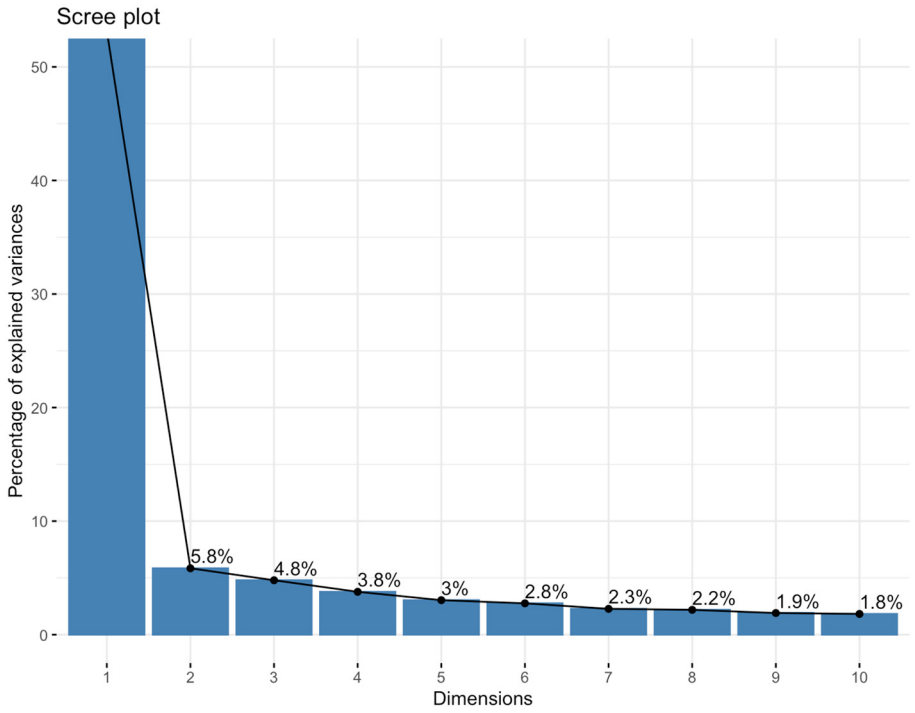


FIGURE 6
Scree plot for the first 10 PCs. The scree plot orders the eigenvalues from largest to smallest to determine how the data are spread out over the PC. The first six PCs have eigenvalues >1. Source: Author's computation.

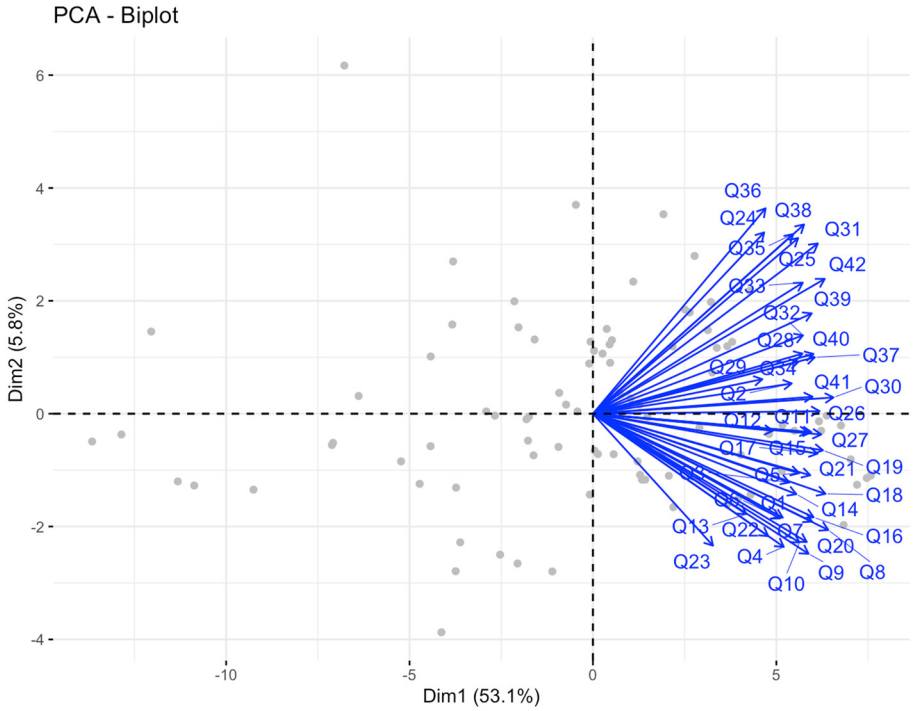


FIGURE 7
Biplot displaying the relationship between variables and the data structure. Source: Author's computation.

TABLE 4 PCs and absolute loadings.

Factors (PC)	Question	Absolute loading	Factor (PC)	Question	Absolute loading
1. Resources and materials	Q30	0.179	4. Clarity of course introduction	Q40	0.320
	Q8	0.175		Q12	0.312
	Q18	0.173		Q35	0.277
	Q42	0.173		Q23	0.231
	Q19	0.171		Q3	0.229
	Q27	0.170		Q4	0.226
	Q26	0.169		Q41	0.221
	Q31	0.167		Q19	0.213
	Q17	0.167		Q6	0.197
	Q37	0.165		Q17	0.197
2. Learner's interaction and engagement, and learner's technical support	Q36	0.300	5. Clarity, learner's support, and engagement	Q6	0.333
	Q38	0.276		Q14	0.273
	Q24	0.264		Q12	0.269
	Q35	0.262		Q24	0.245
	Q25	0.256		Q37	0.234
	Q31	0.248		Q34	0.232
	Q9	0.204		Q29	0.221
	Q42	0.197		Q3	0.217
	Q4	0.194		Q28	0.211
	Q23	0.193		Q4	0.211
3. Course overview and introduction	Q23	0.422	6. Assessment and technical support	Q11	0.358
	Q29	0.367		Q14	0.297
	Q2	0.345		Q13	0.273
	Q1	0.259		Q34	0.250
	Q5	0.249		Q27	0.235
	Q22	0.248		Q2	0.207
	Q12	0.197		Q36	0.204
	Q3	0.189		Q37	0.203
	Q37	0.170		Q8	0.201
	Q4	0.161		Q33	0.194

Table on PCA and its absolute loadings. Source: Author's computation.

overviews contribute to early student engagement and improved learning outcomes. This finding has great implications for HEIs on the need to ensure that online courses include comprehensive and accessible introductory materials to orient students effectively.

The implications of PC 4 and PC 5, both focused on "Assessment Feedback and Learner Support," affirm the ongoing debate by suggesting that formative feedback loops are essential components of metacognition and serve as anchors for CT. However, it is not only the assessment itself but also the quality and timing of feedback that fosters reflection and deeper learning (Wolcott and Sargent, 2021). Relating this to the constructivist pedagogy, learners often benefit from clear expectations and accessible learning environments. The TAM supports the idea of clarity and ease of access, which enhances user satisfaction and ongoing engagement. The study by Deuser et al. (2023) also supports this connection, as it is argued that the course overview and introduction are essential for online learning success because they set the tone for student engagement throughout the course. Furthermore, the more engaging the students find the course components, the more likely that it will spark the development of CT skills. This finding has implications for instructors and educators generally on the importance of considering the

accessibility and clarity of their course materials, as these are the foundation of enabling CT skills development.

As for the feedback, our findings underscore the importance of continuous feedback and peer interaction, as these are found to be instrumental in promoting CT. This finding builds upon the study by Alismaiel et al. (2022) and Martin et al. (2016) where it was stressed that online learning increases learners' engagement. As a result, instructors and HEIs must prioritize timely feedback and encourage team-building/collaboration to support students' analytical skills.

The final component, i.e., PC 6, combines assessment feedback and technical support, and highlights the integration of pedagogical and infrastructural elements. Students' positive ratings for this PC suggest that technology-enabled feedback can bridge the digital divide, especially when institutions invest in stable platforms and responsive support. In line with the CLT pedagogy, feedback is a central mechanism for reflection and knowledge construction. The TAM approach also underscores the significance of support in encouraging the use of technology. Literature (e.g., Conklin and Barreto, 2023; Wolcott and Sargent, 2021) stressed that timely feedback is essential for CT skill development. Given this finding, stakeholders, including instructors and HEIs, must ensure that assessments are not only meaningful but are supported by accessible feedback and technical infrastructure to encourage student reflection and CT development.

Overall, these findings validate the QM rubrics as not just a mere checklist but as an enabler of higher-order thinking skills when applied holistically. The results do not merely confirm alignment but point to specific QM dimensions that are underperforming, specifically those related to interaction and engagement. This underlines an important pedagogical implication, namely, effective CT development in online learning requires not just strong content but also intentional design around interaction, feedback, and accessibility.

Future recommendations for course designs should go beyond structural compliance with QM and embed more targeted interventions such as moderated discussions, real-world case simulations, and dynamic feedback loops to enhance students' cognitive engagement.

4.3.3 Comparative reflection on the South African context and the digital divide

A crucial contextual aspect in interpreting these study findings is South Africa's persistent digital divide, which remains a structural obstacle to equitable online learning. While the QM rubrics offer a structured and standardized approach to assessing online course design, their effective implementation assumes consistent access to digital infrastructure, a condition that may be limited in the South African higher education context due to unequal Internet access, lack of devices, and limited digital literacy skills. South Africa, like many emerging nations, continues to face a significant digital divide, particularly among students from historically disadvantaged groups and those from rural regions. This disparity in access to digital infrastructure, such as devices, reliable Internet connectivity, and technological support, has continuously influenced the quality and inclusiveness of online education (Mwansa et al., 2025).

Recent research suggests that, while institutions have made strides in adopting digital learning platforms, unequal digital readiness remains a substantial barrier to effective student engagement and CT development (Dlamini et al., 2024). Limited access to digital equipment experienced by many students not only restricts their interaction with course content but also hinders collaborative learning and real-time communication with their instructors and peers, an element emphasized by the QM rubric.

Woldegiorgis (2022) emphasizes that the COVID-19 pandemic amplified these inequalities, demonstrating how socio-economic disadvantages and geographic location have a direct impact on students' learning performance in online environments. Similarly, Chomunorwa et al. (2023) stressed that the structural legacy of the apartheid-era policies persists in digital exclusion, necessitating deliberate interventions to promote inclusive online pedagogy.

Given these contextual realities, this study emphasizes the significance of integrating online course design with localized policies to bridge the digital divide. Improving accessibility and usability, as noted in this study's highest-rated QM standard, should extend beyond interface design to incorporate broader aspects of digital equity. Future efforts must aim at enhancing digital infrastructure and institutional support schemes so that all students, regardless of their socio-economic status, can participate meaningfully in CT and collaborative learning through online platforms.

5 Conclusion, limitations, and recommendations for future research

This study examined the impact of QM-certified online learning on CT skills among accounting students at a South African university. Factor analysis of student perception data demonstrated that online accounting courses designed using QM rubrics influence students' CT skills. Essential components that enable CT development include course resources, technology, learner engagement, and institutional technical support. Furthermore, the PCA identified six core areas comprising resources and materials, learner interaction, course overview, course clarity, support and engagement, and feedback systems as pivotal to fostering CT. The study reinforced the alignment between the TAM and the CLT in supporting how well-structured, accessible, and interactive online learning environments contribute to deeper analytical thinking. The study concludes that structured alignment of course elements with QM standards supports effective CT skill development for accounting students in an online learning environment.

The study hereby recommends institutions to prioritize integrating interactive and accessible digital resources, like downloadable content and engaging media tools, into their online accounting courses. These elements are important to significantly foster students' CT skills when aligned with QM standards. Course developers should promote and ensure adherence to structured online course designs, and educators are encouraged to adopt and align their online course designs with appropriate frameworks, paying attention to the integration of interactive resources, learner engagement, and an accessible support system. Most importantly, consideration should be given to CT-oriented content, adequate

feedback mechanisms, and digital equity to enhance student learning outcomes and thus, bridge the technological divide.

Despite the study's rich contribution, it is not without its limitations. The study focused on a single institution, limiting the generalizability of the findings to broader educational contexts. The reliance on self-reported data may have introduced potential biases, such as social desirability or misinterpretation of survey items. In addition, while factor analysis effectively revealed underlying component structures, it may not have captured the dynamic evolution of CT skills. Moreover, the study assessed perceived rather than demonstrated CT outcomes, which may differ from the actual skill's development. Future studies are therefore encouraged to expand the sample scope to include multiple institutions and other disciplines to enhance the generalizability and explore cross-contextual patterns. Longitudinal designs could also provide deeper insights into how CT skills evolve with sustained exposure to online learning platforms. Furthermore, incorporating objective measures of CT, like performance tasks or content analysis of student assignments, can complement perception-based findings. Finally, further research could investigate the role of emerging technologies and how their integration into the QM framework could influence CT development across diverse learner populations.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by School of Accounting Research Ethics Committee (SAREC) of the University of Johannesburg, South Africa with the code SAREC20230314/08. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

NG: Investigation, Validation, Methodology, Writing – review & editing, Software, Visualization, Writing – original draft, Formal analysis, Conceptualization. HC: Supervision, Conceptualization, Methodology, Validation, Visualization, Writing – review & editing. TM: Data curation, Validation, Conceptualization, Project administration, Writing – review & editing, Investigation.

Funding

The author(s) declare that no financial support was received for the research and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2025.1642266/full#supplementary-material

References

Adigun, O. T., Mpofu, N., and Maphalala, M. C. (2025). Fostering self-directed learning in blended learning environments: a constructivist perspective in higher education. *Higher Educ. Q.* 79:e12572. doi: 10.1111/hequ.12572

Afify, M. K. (2019). The influence of group size in the asynchronous online discussions on the development of critical thinking skills, and on improving students' performance in online discussion forum. *Int. J. Emerg. Technol. Learn.* 14, 132–152. doi: 10.3991/ijet.v14i05.9351

Al Fayyoumi, K., Ali Almousa, N., and Yassin, B. (2025). Faculty perspectives on blended learning in Jordanian universities: opportunities and challenges. *Front. Educ.* 10, 1–16. doi: 10.3389/feduc.2025.1534047

Al-Husban, N. A. (2020). Critical thinking skills in asynchronous discussion forums: a case study. *Int. J. Technol. Educ.* 3:82. doi: 10.46328/ijte.v3i2.22

Alismaiel, O. A., Cifuentes-Faura, J., and Al-Rahmi, W. M. (2022). Online learning, mobile learning, and social media technologies: an empirical study on constructivism theory during the COVID-19 pandemic. *Sustainability* 14, 1–15. doi: 10.3390/su141811134

Alizadeh, M., Mehran, P., Koguchi, I., and Takemura, H. (2019). Evaluating a blended course for Japanese learners of English: why Quality Matters. *Int. J. Educ. Technol. Higher Educ.* 16, 1–21. doi: 10.1186/s41239-019-0137-2

Alkhwaldi, A. F. (2024). Investigating the social sustainability of immersive virtual technologies in higher educational institutions: students' perceptions toward metaverse technology. *Sustainability* 16:934. doi: 10.3390/su16020934

Alkramiti, A. M., and Alsharidah, M. A. (2022). Evaluating the design of mathematics courses available on the blackboard platform at prince sattam bin abdulaziz university according to Quality Matters standards. *Eurasia J. Math. Sci. Technol. Educ.* 18:2098. doi: 10.29333/ejmste/11924

Almaiah, M. A., Alhumaid, K., Aldhuhoori, A., Alnazzawi, N., Aburayya, A., Alfaisal, R., et al. (2022). Factors affecting the adoption of digital information technologies in higher education: an empirical study. *Electronics* 11:3572. doi: 10.3390/electronics11213572

Al-Mamary, Y. H., Abubakar, A. A., and Abdulrab, M. (2023). The effects of the expectation confirmation model (ECM) and the technology acceptance model (TAM) on learning management systems (LMS) in sub-saharan Africa. *Interactive Learn. Environ.* 32, 3875–3891. doi: 10.1080/10494820.2023.2191272

Alpala, L. O., Quiroga-Parra, D. J., Torres, J. C., and Peluffo-Ordóñez, D. H. (2022). Smart factory using virtual reality and online multi-user: towards a metaverse for experimental frameworks. *Appl. Sci.* 12:6258. doi: 10.3390/app12126258

Al-Sayid, F., and Kirkil, G. (2025). Integrating technology acceptance model with UTAUT to increase the explanatory power of the effect of HCI on students' intention to use E-learning system and perceive success. *IEEE Access* 13, 20720–20739. doi: 10.1109/ACCESS.2025.3534740

Alshammari, S. H., and Alkhwaldi, A. F. (2025). An integrated approach using social support theory and technology acceptance model to investigate the sustainable use of digital learning technologies. *Sci. Rep.* 15, 1–13. doi: 10.1038/s41598-024-83450-z

Baber, H. (2020). Determinants of students' perceived learning outcome and satisfaction in online learning during the pandemic of COVID19. *J. Educ. E-Learn. Res.* 7, 285–292. doi: 10.20448/journal.509.2020.73.285.292

Bada, S. O., and Olusegun, S. (2015). Constructivism learning theory: a paradigm for teaching and learning. *J. Res. Method Educ.* 5, 66–70. Available online at: https://www.iosrjournals.org/iosr-jrme/papers/Vol-5%20Issue-6/Version-1/I05616670.pdf

Barczyk, C. C., Hixon, E., Buckenmeyer, J., and Ralston-Berg, P. (2017). The effect of age and employment on students' perceptions of online course quality. *Am. J. Distance Educ.* 31, 173–184. doi: 10.1080/08923647.2017.1316151

Brandon, G. (2024). *Bridging the Digital Divide in South Africa: Pathways to Inclusive Educational Technology*. Regent Business School. Available at: https://regent.ac.za/blog/bridging-digital-divide-south-africa#:\sim:text=In (Accessed April 12, 2025).

Braun, N. M. (2004). Critical thinking in the business curriculum. *J. Educ. Business* 79, 232–236. doi: 10.1080/08832323.2020.12088718

Brown, V. S., Toussaint, M., and Lewis, D. (2018). Students' perceptions of quality across four course development models. *Online Learn. J.* 22, 173–196. doi: 10.24059/olj.v22i2.1213

Calma, A., and Davies, M. (2021). Critical thinking in business education: current outlook and future prospects. *Stud. Higher Educ.* 46, 2279–2295. doi: 10.1080/03075079.2020.1716324

Chang, C. Y., Panjaburee, P., Lin, H. C., Lai, C. L., and Hwang, G. H. (2022). Effects of online strategies on students' learning performance, self-efficacy, self-regulation, and critical thinking in university online courses. *Educ. Technol. Res. Dev.* 70, 185–204. doi: 10.1007/s11423-021-10071-y

Chomunorwa, S., Mashonganyika, E. S., and Marevesa, A. (2023). Digital transformation and post-Covid-19 education in South Africa: a review of literature. *South Afr. Comput. J.* 35, 91–100. doi: 10.18489/sacj.v35i1.1101

Cloete, M. (2018). The impact of an integrated assessment on the critical thinking skills of first-year university students. *Account. Educ.* 27, 479–494. doi: 10.1080/09639284.2018.1501717

Conklin, S., and Barreto, D. (2023). Student perceptions of Quality Matters standards on engagement and learning. *Am. J. Distance Educ.* 39, 195–209. doi: 10.1080/08923647.2023.2242734

Cortázar, C., Nussbaum, M., Harcha, J., Alvares, D., López, F., Goñi, J., et al. (2021). Promoting critical thinking in an online, project-based course. *Comput. Human Behav.* 119:106705. doi: 10.1016/j.chb.2021.106705

Darwin, Rusdin, D., Mukminatien, N., Suryati, N., Laksmi, E. D., and Marzuki (2024). Critical thinking in the AI era: an exploration of EFL students' perceptions, benefits, and limitations. *Cogent Educ.* 11:2290342. doi: 10.1080/2331186X.2023.2290342

Davis, F. D., Bagozzi, R. P., and Warshaw, P. R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Manage. Sci.* 35, 982–1003. doi: 10.1287/mnsc.35.8.982

Dehghani, H., and Mashhadi, A. (2024). Exploring Iranian English as a foreign language teachers' acceptance of ChatGPT in English language teaching: extending the technology acceptance model. *Educ. Inf. Technol.* 29, 19813–19834. doi: 10.1007/s10639-024-12660-9

Deuser, K., Sanchez, R. P., Mendoza-Moran, A., Winzeler, B., Zheng, Y., and Trivedi, S. (2023). Student perceptions of the impact of Quality Matters essential standards in an animal physiology course. *Transl. Anim. Sci.* 7:txad112. doi: 10.1093/tas/txad112

Dlamini, R., Louw, T. (Arno), and Yu, K. (2024). "Digital-centric higher education an African perspective," in *Higher Education ICT Integration in Africa*, eds. K. Yu and R. Dlamini (London: Routledge), 5–24. doi: 10.4324/9781003394877-2

Ernita, N., Bahtiar, B., Zulkarnaen, Z., Mustofa, H. A., and Faresta, R. A. (2024). Online self-regulated learning assisted by virtual labs to train STEM students' critical thinking skills. *Int. J. Essential Competencies Educ.* 3, 28–46. doi: 10.36312/ijece.v3i1.1917

European Commission (2016). *European Political Strategy Centre, The Future of Work – Skills and Resilience for a World of Change*. European Union. Available at: https://data.europa.eu/doi/10.2872/262000 (Accessed March 3, 2025).

Feyzi Behnagh, R., and Yasrebi, S. (2020). An examination of constructivist educational technologies: key affordances and conditions. *Br. J. Educ. Technol.* 51, 1907–1919. doi: 10.1111/bjet.13036

Foo, S. Y., and Quek, C. L. (2019). Developing students' critical thinking through online discussions: a literature review. *Malaysian Online J. Educ. Technol.* 7, 37–58. doi: 10.17220/mojet.2019.02.003

Getenet, S., Cantle, R., Redmond, P., and Albion, P. (2024). Students' digital technology attitude, literacy and self-efficacy and their effect on online learning engagement. *Int. J. Educ. Technol. Higher Educ.* 21, 1–20. doi: 10.1186/s41239-023-00437-y

Giacumo, L. A., and Savenye, W. (2020). Asynchronous discussion forum design to support cognition: effects of rubrics and instructor prompts on learner's critical thinking, achievement, and satisfaction. *Educ. Technol. Res. Dev.* 68, 37–66. doi: 10.1007/s11423-019-09664-5

Gonzalez-Cacho, T., and Abbas, A. (2022). Impact of interactivity and active collaborative learning on students' critical thinking in higher education. *Rev. Iberoamericana Tecnol. Aprendizaje* 17, 254–261. doi: 10.1109/RITA.2022.3191286

Han, Y., Yang, S., Han, S., He, W., Bao, S., and Kong, J. (2025). Exploring the relationship among technology acceptance, learner engagement and critical thinking in the Chinese college-level EFL context. *Educ. Inf. Technol.* 1–24. doi: 10.1007/s10639-025-13375-1

Harkness, S. S. J. (2015). How a historically black college university (HBCU) established a sustainable online learning program in partnership with Quality Matters TM. *Am. J. Distance Educ.* 29, 198–209. doi: 10.1080/08923647.2015.1057440

Herodotou, C., Aristeidou, M., Scanlon, E., and Kelley, S. (2022). Virtual microscopes and online learning: exploring the perceptions of 12 teachers about pedagogy. *Open Learn.* 40, 4–28. doi: 10.1080/02680513.2022.2112661

Hollowell, G. P., Brooks, R. M., and Anderson, Y. B. (2017). Course design, Quality Matters training, and student outcomes. *Am. J. Distance Educ.* 31, 207–216. doi: 10.1080/08923647.2017.1301144

Hu, S. G., Wang, W. Y., Wang, X. X., and Yin, Y. M. (2024). Assessing the intention to accept inquiry-based teaching pedagogy among Chinese university students: an extension of technology acceptance model. *Front. Psychol.* 15:1265047. doi: 10.3389/fpsyg.2024.1265047

Hyytinen, H., Toom, A., and Shavelson, R. J. (2019). "Enhancing scientific thinking through the development of critical thinking in higher education," in *Redefining Scientific Thinking for Higher Education: Higher-Order Thinking, Evidence-Based Reasoning and Research Skills*, eds. M. Murtonen and K. Balloo (London: Palgrave Macmillan), 59–78. doi: 10.1007/978-3-030-24215-2_3

International Federation of Accountants (2021). *Part IES 2: Initial Professional Development – Technical Competence*. Advancing Accountancy Education. Available at: https://education.ifac.org/part/ies-3 (Accessed February 28, 2025).

Jääskelä, P., Nykänen, S., and Tynjälä, P. (2018). Models for the development of generic skills in Finnish higher education. *J. Further Higher Educ.* 42, 130–142. doi: 10.1080/0309877X.2016.1206858

Jaswal, P., and Behera, B. (2024). Blended matters: nurturing critical thinking. *E-Learn. Digital Media* 21, 106–124. doi: 10.1177/20427530231156184

Jayasinghe, K. (2021). Constructing constructivism in management accounting education: reflections from a teaching cycle with innovative learning elements. *Qual. Res. Account. Manage.* 18, 282–309. doi: 10.1108/QRAM-05-2020-0067

Joosten, T., and Cusatis, R. (2019). A cross-institutional study of instructional characteristics and student outcomes: are quality indicators of online courses able to predict student success? *Online Learn. J.* 23, 354–378. doi: 10.24059/olj.v23i4.1432

Kaiser, H. F. (1960). The application of electronic computers to factor analysis. *Educ. Psychol. Meas.* 20, 141–151. doi: 10.1177/001316446002000116

Kauffman, H. (2015). "A review of predictive factors of student success in and satisfaction with online learning," in *Research in Learning Technology, Vol. 23*, ed. M. O'Reilly (Co-Action Publishing), 26507. doi: 10.3402/rlt.v23.26507

Kemp, A., Palmer, E., Strelan, P., and Thompson, H. (2024). Testing a novel extended educational technology acceptance model using student attitudes towards virtual classrooms. *Br. J. Educ. Technol.* 55, 2110–2131. doi: 10.1111/bjet.13440

Kleemola, K., Hyytinen, H., and Toom, A. (2022). The challenge of position-taking in novice higher education students' argumentative writing. *Front. Educ.* 7:885987. doi: 10.3389/feduc.2022.885987

krejcie, R., and Stanley, M. (1970). Determining sample size for research activities. *Educ. Psychol. Meas.* 30, 607–610. doi: 10.1177/001316447003000308

Kumar, S., Martin, F., Budhrani, K., and Ritzhaupt, A. (2019). Award-winning faculty online teaching practices: elements of award-winning courses. *Online Learn. J.* 23, 160–180. doi: 10.24059/olj.v23i4.2077

Lamri, J., Barabel, M., and Meier, O. (2018). *21st Century Skills - How to Make a Difference? Creativity, Communication, Critical Thinking, Cooperation*. Dunod. Available at: https://www.dunod.com/entreprise-et-economie/competences-du-21e-siecle-comment-faire-difference-creativite-communication (Accessed March 3, 2025).

Lefrid, M., Cavusoglu, M., Richardson, S., and Donnelly, C. (2023). Simulation-based learning acceptance model (SBL-AM): expanding the technology acceptance model (TAM) into hospitality education. *J. Hospital. Tourism Educ.* 36, 333–347. doi: 10.1080/10963758.2023.2188217

Lew, D. N. M., Seow, P. S., Pan, G., and Goh, C. (2025). Undergraduate accounting capstone: enhancing integration, reflective learning, and workplace transition for future professionals. *Account. Educ.* 1–36. doi: 10.1080/09639284.2025.2488983

Lin, M., Liu, L. Y. J., and Pham, T. N. (2023). Towards developing a critical learning skills framework for master's students: evidence from a UK university. *Think. Skills Creativity* 48:101267. doi: 10.1016/j.tsc.2023.101267

Liu, Z., Zhang, X., Liu, W., Chen, W., Li, Y., and Zhou, Y. (2025). Application and optimization of digital situated teaching in university finance courses from a constructivist perspective: an analysis based on machine learning algorithms. *Educ. Inf. Technol.* 1–30. doi: 10.1007/s10639-025-13496-7

Luckin, R. (2024). Nurturing human intelligence in the age of AI: rethinking education for the future. *Dev. Learn. Org.* 39, 1–4. doi: 10.1108/DLO-04-2024-0108

Martin, F., Ndoye, A., and Wilkins, P. (2016). Using learning analytics to enhance student learning in online courses based on Quality Matters standards. *J. Educ. Technol. Syst.* 45, 165–187. doi: 10.1177/0047239516656369

Mathur, S., Tewari, A., Vishnoi, S., and Agarwal, V. (2024). An integrated model to predict students' online learning behavior in emerging economies: a hybrid SEM–ANN approach. *J. Int. Educ. Business* 18, 102–126. doi: 10.1108/JIEB-01-2024-0004

Musundwa, S. (2024). Implementing constructivist teaching to foster inclusive educational practices in accounting programmes. *Accoun. Educ.* 1–34. doi: 10.1080/09639284.2024.2367132

Mwansa, G., Ngandu, M. R., and Mkwambi, Z. (2025). Bridging the digital divide: exploring the challenges and solutions for digital exclusion in rural South Africa. *Discover Global Soc.* 3, 1–24. doi: 10.1007/s44282-025-00189-2

Nwosu, L. I., and Vorster, H. (2021). A systematic literature review on critical thinking in an undergraduate accounting programme. *Int. J. Financial Res.* 12:225. doi: 10.5430/ijfr.v12n4p225

OECD (2019). *OECD Future of Education and Skills for 2030*. OECD. Available at: https://www.oecd.org/education/2030-project/teaching-and-learning/learning/skills/Skills_for_2030_concept_note.pdf (Accessed March 10, 2025).

Orhan, A. (2024). Online or in-class problem based learning: which one is more effective in enhancing learning outcomes and critical thinking in higher education EFL classroom? *J. Comput. Assist. Learn.* 40, 2351–2368. doi: 10.1111/jcal.13033

Ospankulova, E., Maxutov, S., Lathrop, R., Anuarova, L., and Balta, N. (2025). Science students' attitudes, learning, critical thinking and engagement in project-based learning. *Cogent Educ.* 12:2445358. doi: 10.1080/2331186X.2024.2445358

Papageorgiou, E. (2023). The inclusion of critical thinking in an accounting curriculum: Students' perceptions. *J. Educ.* 91, 132–154. doi: 10.17159/2520-9868/i91a08

Pedraja-Rejas, L., Muñoz-Fritis, C., Rodríguez-Ponce, E., and Laroze, D. (2024). Mobile learning and its effect on learning outcomes and critical thinking: a systematic review. *Appl. Sci.* 14:9105. doi: 10.3390/app14199105

Pincus, K. V., Stout, D. E., Sorensen, J. E., Stocks, K. D., and Lawson, R. A. (2017). Forces for change in higher education and implications for the accounting academy. *J. Account. Educ.* 40, 1–18. doi: 10.1016/j.jaccedu.2017.06.001

Quality Matters (2023). *Standards from the QM higher Education Rubric, 7th Edn*. Quality Matters Organization. Available at: https://www.qualitymatters.org/qa-resources/rubric-standards (Accessed February 28, 2025).

Quality Matters (2025a). *QM Member List*. Available at: https://www.qualitymatters.org/members (Accessed March 11, 2025).

Quality Matters (2025b). *Why Quality Matters*. Available at: https://www.qualitymatters.org/why-quality-matters/about-qm (Accessed February 28, 2025).

Rossouw, M., and Steenkamp, G. (2025). Developing the critical thinking skills of first year accounting students with an active learning intervention. *Int. J. Manage. Educ.* 23:101086. doi: 10.1016/j.ijme.2024.101086

Sadaf, A., Martin, F., and Ahlgrim-Delzell, L. (2019). Student perceptions of the impact of Quality Matters–certified online courses on their learning and engagement. *Online Learn. J.* 23, 214–233. doi: 10.24059/olj.v23i4.2009

Simelane-Mnisi, S. (2023). Effectiveness of LMS digital tools Uued by the academics to foster students' engagement. *Educ. Sci.* 13:980. doi: 10.3390/educsci13100980

South African Institute of Professional Accountants (SAIPA) (2019). *In the 4IR Era, Professional Accountants Must Develop Critical Thinking*. SAIPA. Available at: https://www.saipa.co.za/in-the-4ir-era-professional-accountants-must-develop-critical-thinking/ (Accessed February 28, 2025).

Stanley, T., and Marsden, S. (2012). Problem-based learning: does accounting education need it? *J. Account. Educ.* 30, 267–289. doi: 10.1016/j.jaccedu.2012.08.005

Su, T., Liu, J., Meng, L., Luo, Y., Ke, Q., and Xie, L. (2025). The effectiveness of problem-based learning (PBL) in enhancing critical thinking skills in medical education: a systematic review and meta-analysis. *Front. Educ.* 10:1565556. doi: 10.3389/feduc.2025.1565556

Suliman, M. A. E., Zhang, W., and Sleiman, K. A. A. (2023). Factors affecting students' intention to use m-learning: extending the technology acceptance model (TAM). *Innov. Educ. Teach. Int.* 61, 1184–1199. doi: 10.1080/14703297.2023.2239203

Sun, D., Looi, C. K., Yang, Y., and Jia, F. (2025). Exploring students' learning performance in computer-supported collaborative learning environment during and after pandemic: cognition and interaction. *Br. J. Educ. Technol.* 56, 128–149. doi: 10.1111/bjet.13492

Taber, K. S. (2018). The use of Cronbach's Alpha when developing and reporting research instruments in science education. *Res. Sci. Educ.* 48, 1273–1296. doi: 10.1007/s11165-016-9602-2

Tathahira, T. (2020). Promoting students' critical thinking through online learning in higher education: challenges and strategies. *Englisia J. Lang. Educ. Human.* 8, 79–92. doi: 10.22373/ej.v8i1.6636

Terblanche, E. A. J., Shuttleworth, C. C., van Rooyen, A. A., and Masela, R. N. (2023). Critical thinking: stakeholder expectations and challenges for accountancy educators. *South Afr. J. Account. Res.* 37, 225–244. doi: 10.1080/10291954.2022.2148925

Tettamanzi, P., Minutiello, V., and Murgolo, M. (2023). Accounting education and digitalization: a new perspective after the pandemic. *Int. J. Manage. Educ.* 21:100847. doi: 10.1016/j.ijme.2023.100847

Tuononen, T., Hyytinen, H., Kleemola, K., Hailikari, T., Männikkö, I., and Toom, A. (2022). Systematic review of learning generic skills in higher education—enhancing and impeding factors. *Front. Educ.* 7:885917. doi: 10.3389/feduc.2022.885917

Tuononen, T., Hyytinen, H., Kleemola, K., Hailikari, T., and Toom, A. (2025). Generic skills in higher education–teachers' conceptions, pedagogical practices and pedagogical training. *Teach. Higher Educ.* 30, 207–224. doi: 10.1080/13562517.2023.2248003

Turakhia, D., Ludgin, D., Mueller, S., and Desportes, K. (2024). Understanding the educators' practices in makerspaces for the design of education tools. *Educ. Technol. Res. Dev.* 72, 329–358. doi: 10.1007/s11423-023-10305-1

Turnbull, D., Chugh, R., and Luck, J. (2021). Learning management systems: a review of the research methodology literature in Australia and China. *Int. J. Res. Method Educ.* 44, 164–178. doi: 10.1080/1743727X.2020.1737002

Velez, G., and Power, S. A. (2020). Teaching students how to think, not what to think: pedagogy and political psychology. *J. Soc. Polit. Psychol.* 8, 388–403. doi: 10.5964/jspp.v8i1.1284

Vijayakumar Bharathi, S., and Pande, M. B. (2024). Does constructivism learning approach lead to developing creative thinking skills? The mediating role of online collaborative learning environments. *J. Comput. Educ.* 37, 551–587. doi: 10.1007/s40692-024-00321-2

Virtanen, A., and Tynjälä, P. (2019). Factors explaining the learning of generic skills: a study of university students' experiences. *Teach. Higher Educ.* 24, 880–894. doi: 10.1080/13562517.2018.1515195

Wolcott, S. K., and Sargent, M. J. (2021). Critical thinking in accounting education: status and call to action. *J. Account. Educ.* 56:100731. doi: 10.1016/j.jaccedu.2021.100731

Woldegiorgis, E. T. (2022). Mitigating the digital divide in the South African higher education system in the face of the Covid-19 pandemic. *Perspect. Educ.* 40, 197–211. doi: 10.18820/2519593X/pie.v40.i3.13

World Economic Forum (2022). *The Future of Jobs Report 2020*, 1163. Available at: https://www.weforum.org/publications/the-future-of-jobs-report-2020/ (Accessed March 3, 2025).