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PAPER

Designing Effective Online Learning Paths in Cloud Computing Education: Bridging Pedagogical Theory and Practice in Higher Education

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ABSTRACT

Cloud computing is a critical skill in today's world, and nearly all universities worldwide offer online platforms to meet the high demand for computing courses. While these courses provide knowledge and hands-on practice, there remains a gap in instructional course design. This paper explores how online cloud computing courses are structured and to what extent they apply educational theories such as Bloom's Taxonomy and Gagné's Nine Events of Instruction. Using a qualitative, multiple case study approach, the paper analyzes three real-world examples: AWS Academy Cloud Foundations, Google Cloud Skills Boost, and a Scratch-based course developed at the University of Salerno. These cases show different approaches to managing content, guiding student progress, and supporting active learning. While some platforms focus on tools and task completion, others emphasize learning goals, feedback, and scaffolding. The study suggests that cloud platforms provide adaptability but often lack effective instructional design. Courses should focus on structured learning paths, incorporating reflection and feedback. This paper proposes a five-step framework to improve online cloud computing courses by integrating academic theory with practical delivery, contributing to digital education, and offering guidance for instructors, course designers, and institutions to enhance student engagement and skill mastery.

KEYWORDS

online learning, cloud computing, education, pedagogical theory, higher education, academy cloud foundation

1 INTRODUCTION

In recent years, cloud computing has reshaped how businesses, educational institutions, and governments store, process, and manage data. Its adaptability, cost-effectiveness, and scalability have made it effective in nearly every digital system [1]. As global demand grows for professionals skilled in cloud computing,

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these institutions face pressure to meet the demand for skilled cloud professionals globally and to provide training that aligns with real-world needs, also offering them training accordingly [2]. Consequently, a promising solution has emerged: a shift to online learning supported by cloud computing infrastructure itself. Many institutions now offer cloud computing courses, and there has been a rapid increase in the number of courses recently, but many still have gaps in their course design that support deep learning. This proposal focuses on a critical gap: how to bridge academic research and practical course design to build more effective online learning paths for cloud computing education.

Online learning in cloud computing is mostly offered through massive open online courses (MOOCs), university platforms, and vendor-based programs such as AWS Academy, Microsoft Learn, and Google Cloud Skills Boost. These platforms use interactive tools, sandbox environments, and hands-on labs to provide students with practical experience [3]. But research results show that technical content alone is not enough. Still, many students struggle with course navigation, unclear learning outcomes, and lack of feedback, particularly in self-paced environments [4]. This suggests that there is no connection between the educational theory supporting learner-centered design and the actual structure of online cloud computing courses. Instructional design models such as Bloom's Taxonomy and Gagné's Nine Events of Instruction have previously been used to enhance teaching and learning goals. Bloom's Taxonomy helps instructors set learning goals that progress from basic to higher-level thinking [5]. Gagné's model focuses on structured steps in learning, from gaining attention to offering feedback and supporting retention [6]. When applied correctly, these frameworks can greatly enhance learner motivation and success. Yet, many online computing courses fail to apply these rules fully, prioritizing tool usage over structured pedagogy [7].

The COVID-19 pandemic increased the pace of digital transformation in education, putting pressure on universities to adopt cloud-based delivery systems almost overnight. As educational institutions realized that digital tools can support learning at scale, it also revealed major gaps in digital course design [8]. Research from Baanqud et al. [9] and Almajalid [10] shows that many online courses lack effective structure, meaning students don't receive enough knowledge according to real-world demand or feedback as they progress. This has had a particularly negative effect in fields such as cloud computing, where students often need to understand basic systems, write code, and troubleshoot configurations all remotely and independently. Additionally, course completion rates in online technical education remain low. According to Hew et al. [11], lack of engagement and cognitive overload are two main reasons learners drop out of online STEM courses. These problems often arise when learning course designs are poorly developed or when teaching data does not match learners' skill levels. For example, when a beginner is introduced to complex DevOps tools without sufficient knowledge background, it can lead to frustration and withdrawal. To address this, some researchers propose adaptive learning paths that adjust according to student progress, but these are still rare in cloud training environments [12].

In a study by Çakiroğlu and Erdemir [13], students in a cloud-based project learning environment reported higher motivation and satisfaction when the course structure was aligned with instructional principles. Similarly, Siddiqui et al. [14] emphasized that cloud-based e-learning must be "pedagogy-driven, not technology-led." Their work shows that integrating learning theories into digital course design leads to better outcomes in both knowledge gain and student confidence. Another problem is the diversity of learners in cloud computing education. Some students may have prior experience with IT infrastructure, while others are beginners. Instructors must therefore build learning paths that are both flexible and structured, offering clear guidance while allowing for independent exploration. Without such design, learners often feel lost or overwhelmed, especially in asynchronous settings [15].

The partnership between universities and cloud service providers adds another layer to this issue. While AWS Academy and similar platforms offer excellent technical content and labs, the role of universities in contextualizing this content is critical. If instructors do not align vendor content with course objectives and learner needs, students may complete modules without fully understanding the concepts behind them [16]. This again highlights the need for integrating academic research and practice using proven teaching strategies to ensure technical content is delivered in ways that support long-term learning. Finally, research also highlights the need for continuous feedback and learner support in online environments. In cloud computing courses, students often encounter errors during hands-on labs and need timely help to stay engaged. The absence of structured support such as automated feedback, peer discussion forums, or instructor interaction reduces the overall effectiveness of the course [17]. Therefore, the design of learning paths must also consider the support systems that enable students to succeed.

This proposal aims to analyze and improve the design of online learning paths for cloud computing education by combining insights from academic instructional theory and real-world online course practice. It will study current online course structures, evaluate how well they follow instructional design principles, and gather feedback from students and instructors. The research will use a mixed-methods approach, combining course analysis, interviews, and surveys. The outcome will be a set of guidelines or frameworks to help universities and educators design more effective, theory-informed cloud computing courses. By bridging the gap between research and practice, this study will contribute to better teaching in cloud computing, help students build real-world skills, and support educational institutions in delivering higher-quality digital training programs.

1.1 Problem statement

Cloud computing, now a core component of digital infrastructure, continues to enhance a key skill area in the global job market. In response, universities and online platforms have rapidly introduced cloud computing courses to prepare students for industry demands. However, while technical content and hands-on tools are widely available, the way these online cloud computing courses are structured remains inconsistent and often lacks pedagogical depth [14], [7]. Many programs focus on delivering technical content through videos and labs but do not fully integrate well-established learning theories or instructional design principles. Academic research in educational psychology and digital learning emphasizes the importance of structured, learner-centered course design. Models such as Bloom's Taxonomy and Gagné's Nine Events of Instruction provide frameworks to support knowledge building, motivation, and retention [5], [6]. Yet, in practice, many cloud computing courses do not align with these models. Instead, they rely heavily on tool usage without providing adequate scaffolding, feedback, or assessment strategies [4], [8]. This gap is especially problematic for students with limited computing experience, who may struggle with disorganized or overly technical paths.

Furthermore, there is a lack of research that specifically examines how academic theory can be applied to real-world online cloud computing course design.

Although many studies discuss the benefits of cloud technology in education, few explore how learning paths in these courses are built, how they support different learner needs, or how they connect to proven teaching strategies [3], [17]. As a result, instructors and course developers lack clear guidance on how to design or adapt online cloud courses that are both technically rigorous and educationally sound. This creates a significant research gap—one that directly affects course quality, student performance, and educational equity in cloud computing education. Without clearer integration of academic research into course design, learners may struggle to gain meaningful, job-ready skills, and institutions risk delivering programs that fall short of learning outcomes [12], [16].

Therefore, this study seeks to investigate how instructional design theories can be effectively applied to the development of online learning paths in cloud computing education, with the goal of improving both learner engagement and skill development. The findings will offer valuable insight for universities, instructors, and instructional designers looking to improve course effectiveness in a fast-evolving digital education landscape.

2 LITERATURE REVIEW

2.1 Cloud computing in higher education

Cloud computing has significantly changed how digital infrastructure is used in education. Universities and training institutions have adopted cloud-based platforms to deliver content, offer practical experiences, and manage data more efficiently [8]. Services such as Amazon Web Services (AWS), Microsoft Azure, and Google Cloud are commonly integrated into university IT programs, especially for subjects that require hands-on technical training. The flexibility, scalability, and affordability of cloud systems make them well suited for large-scale online learning [1]. In particular, cloud-based virtual labs allow students to experiment with real-world tools without needing expensive hardware or software installed on personal devices. These platforms also make it easier for educators to update content, monitor student progress, and personalize learning materials [7]. However, despite these advantages, research shows that simply offering cloud access does not guarantee effective learning. Many cloud-based courses focus heavily on technical features while neglecting the pedagogical structure needed to help learners build knowledge step-by-step [14]. This challenge becomes more serious when students with diverse learning styles or academic backgrounds enter the same cloud course without tailored pathways.

2.2 Instructional design theories in online learning

Instructional design theories provide useful tools for building meaningful and structured learning experiences. Among the most widely used models are Bloom's Taxonomy and Gagné's Nine Events of Instruction. Bloom's framework helps organize learning objectives from simple recall to more advanced skills such as analysis and creation [5]. In cloud computing courses, this model can be used to design content that supports both theoretical understanding and practical application. Gagné's model offers a sequence of events such as gaining attention, presenting content, offering guidance, and giving feedback. These steps are especially useful in online learning environments where student motivation and focus can be difficult to maintain [6]. Despite the strong evidence supporting these models, research shows that they are rarely applied in technical online programs, which tend to prioritize software training over instructional quality [4]. Some efforts to bridge this gap have shown promise. For example, a study by Çakiroğlu and Erdemir [13] found that using structured project-based learning in cloud courses improved student engagement and satisfaction. Their course included goal-setting, step-by-step instructions, peer interaction, and self-assessment tools—all aligned with educational theory. Still, these examples remain the exception rather than the norm, as most online cloud courses remain focused on passive learning formats such as video tutorials and auto-graded quizzes.

2.3 Challenges in technical online course design

Designing effective online courses for technical subjects such as cloud computing presents several challenges. First, learners often struggle to balance theory with practical skills. Without proper scaffolding, beginners may become confused or overwhelmed by the complexity of cloud platforms [17]. Second, there is often a lack of real-time support in asynchronous online courses. When students encounter errors during hands-on labs, they may lack the guidance needed to recover, leading to disengagement or course withdrawal [8]. Another issue is cognitive overload. Research by Hew et al. [11] notes that learners in STEM MOOCs frequently report fatigue and confusion when course materials are dense, unstructured, or presented too quickly. This is especially problematic in cloud computing education, where students must absorb abstract concepts and apply them practically—often with little support. A related concern is digital inequality. Not all students have equal access to reliable internet, powerful computers, or quiet study environments, which further affects their ability to succeed in cloud-based courses [16]. These structural issues must be considered during course design, yet many online platforms treat all students as if they start from the same level.

2.4 Adaptive learning paths in cloud computing courses

One solution gaining attention is the use of adaptive learning paths, where the course content and sequence adjust based on student progress, preferences, or performance. Adaptive systems have been shown to increase learner motivation and reduce dropout rates by offering personalized challenges and support [12]. In cloud computing education, this might involve allowing students to choose beginner or advanced tracks, offering optional deep dives, or adjusting lab difficulty based on quiz results. While this approach is promising, implementation remains limited in cloud-based training environments. Most cloud certification courses and university programs still rely on linear paths, which do not accommodate diverse learning needs [10]. Furthermore, many instructors lack the technical tools or training to implement adaptive courseware effectively. Emerging platforms are beginning to address this. For instance, Google Cloud Skills Boost and AWS Academy have started offering modular, self-paced learning paths. However, these tools still depend on the instructor or institution to organize and contextualize them for student success. Without that intervention, even adaptive tools may fail to deliver effective learning experiences [7].

2.5 Bridging theory and practice in course design

The disconnect between academic research and practical course design is a common theme in online technical education. While many educators are aware of learning theories, they often face time constraints, curriculum mandates, or platform limitations that prevent full application of these models [3]. Additionally, cloud computing instructors often come from industry backgrounds and may not be trained in education theory, further contributing to this gap. Bridging this divide requires not only awareness of theory but also access to practical frameworks that show how to implement theory in technical contexts. According to Han and Trimi [8], collaborative design between subject-matter experts and instructional designers leads to more effective outcomes. Institutions that combine technical content with strong instructional models see higher learner satisfaction, deeper engagement, and stronger performance. Moreover, students themselves support this shift. Surveys show that learners value clear structure, timely feedback, and real-world application more than flashy interfaces or advanced tools [17]. This confirms that sound pedagogy, not just technology, is what drives successful learning in online cloud computing courses.

3 RESEARCH OBJECTIVES AND QUESTIONS

3.1 Research aim

The overall aim of this study is to explore how instructional design principles can be effectively integrated into online cloud computing courses in higher education. It seeks to identify which course design elements contribute to more effective learning paths, better student engagement, and improved skill development in cloud computing education.

3.2 Research objectives

Based on the objectives above, this study will address the following central research question and supporting sub-questions:

i) **Main research question:**
- How can instructional design theory be applied to create effective online learning paths for cloud computing education in higher education?

ii) **Sub-questions:**
- What are the common structural patterns and content delivery methods used in current online cloud computing courses?
- To what extent are instructional design principles (e.g., Bloom's Taxonomy, Gagné's model) present in existing cloud course structures?
- What barriers do students and instructors face in online cloud computing courses in terms of learning engagement and skill acquisition?
- How can academic theory be adapted into practical design strategies that improve learner outcomes in cloud computing education?
- What are the best practices and design elements that contribute to learner success in cloud-based technical courses?

4 METHODOLOGY

4.1 Research design

This study follows a qualitative, case-based research design aimed at exploring how online cloud computing courses are structured and whether their design reflects established instructional theories. As no primary data were collected, this study relies on documented, publicly available designs and published academic sources as its primary evidence base. A multiple case study method has been selected to provide a rich and comparative understanding of how different institutions or platforms approach the construction of online learning paths in cloud computing education. According to Yin [15], the case study approach is well-suited for investigating real-world, complex educational practices where control over variables is not possible. It is also useful when the goal is to explore "how" and "why" something works (or does not work), especially in a specific, bounded context such as cloud computing course delivery. This method allows the researcher to draw insights from existing course models and published teaching cases, making it appropriate for theory-building in the absence of new primary data.

4.2 Case selection criteria

The selection of cases for this study was guided by a purposive sampling strategy, with clearly defined inclusion criteria to ensure relevance and rigor. Specifically, each selected case was required to center on cloud computing or closely related topics within the domain of IT infrastructure. Additionally, the course had to be delivered in an online or blended learning format, thereby aligning with contemporary modes of digital education. To facilitate verifiability and in-depth analysis, only those courses whose materials or instructional structures were documented in academic literature or accessible public platforms were considered. Furthermore, a critical selection criterion was the availability of explicit information regarding the instructional design, pedagogical sequence, or teaching strategies employed, thereby enabling a comprehensive examination of each case within the framework of instructional theory and practice. The three selected cases are:

AWS academy cloud foundations. A widely used course offered through universities in collaboration with AWS. It provides hands-on labs and structured content for students new to cloud computing.

Google cloud skills boost. An open-access training platform offering modular, skill-based cloud learning paths supported by real-time labs and auto-graded exercises.

University of salerno case study (Italy). A course analyzed in peer-reviewed literature used block-based programming and gamification elements to teach foundational cloud computing concepts to university students [4].

These three cases represent diverse approaches—vendor-driven, open access, and university-led allowing for a broad comparison of instructional design strategies.

4.3 Data collection

Given the qualitative nature of this study and its reliance on secondary data sources, information was systematically collected through multiple channels to ensure depth and triangulation. These sources included academic publications detailing course implementation and learner feedback; official course documents and syllabi when publicly accessible; platform walkthroughs that outlined curriculum structure and teaching tools; and peer-reviewed evaluation reports, where available. The data collection focused on key instructional components such as stated course goals and learning outcomes, the organization and progression of learning modules, the types of pedagogical activities employed (e.g., hands-on labs, instructional videos, assessments), and the integration of instructional design principles, including Bloom's taxonomy, scaffolding strategies, and feedback mechanisms. Each selected course was subsequently analyzed using a foundational analytical framework informed by established instructional design theory [5], [6]. This framework comprised five core dimensions: (1) the clarity and specificity of learning objectives, (2) the coherence and structure of content progression, (3) the presence and quality of active learning and learner engagement tools, (4) the robustness of feedback and assessment strategies, and (5) the degree of alignment with recognized theory-based instructional models.

4.4 Data analysis

The analysis employed a thematic coding approach to systematically identify and interpret instructional elements across the selected cases. Each course was initially examined on an individual basis to capture its unique design characteristics, followed by a cross-case comparative analysis to discern patterns and divergences. This process facilitated the identification of common instructional design patterns, structural or pedagogical variations, relative strengths and weaknesses in learner support mechanisms, and the explicit presence or absence of underlying pedagogical frameworks. Thematic codes were developed manually using descriptive labels such as "modular design," "self-paced progression," "real-time feedback," and "instructional alignment." These initial codes were iteratively refined and organized into broader thematic categories to reveal shared instructional practices as well as theoretical and practical gaps across the cases. This coding strategy enabled a nuanced understanding of the extent to which each course embodied principles of instructional design and learner-centered pedagogy.

Trustworthiness and rigor. Although no primary data collection methods such as interviews or surveys were employed, this study relies exclusively on well-documented and authentic secondary sources for all case analyses. To ensure the credibility and trustworthiness of the findings, several methodological safeguards were implemented. First, all course materials were verified through official university or platform websites to confirm their accuracy and relevance. Second, peer-reviewed publications were prioritized in order to ground the analysis in rigorously vetted academic discourse. Third, a transparent and systematically applied coding scheme, informed by established instructional design theory, served as the analytical foundation. Finally, triangulation was employed by cross-referencing multiple types of data sources—such as academic literature, platform walkthroughs, and institutional documents—for each case, thereby enhancing the consistency and validity of interpretations. The application of a theory-driven analytical lens contributes to the overall academic rigor of the study, while the inclusion of diverse instructional models across cases enhances the potential transferability and broader applicability of the findings.

Limitations of the method. This methodology has some limitations. Since it relies on secondary sources, it may not capture real-time student experiences or evolving course formats. Also, the number of cases is limited, and course access is sometimes restricted. However, these constraints are addressed by focusing on well-documented examples and aligning the analysis with clearly defined educational theory.

5 CASE ANALYSIS AND DISCUSSION

This section presents a comparative analysis of three real-world cases of online cloud computing education. It evaluates their learning paths, instructional design strategies, and alignment with established teaching theories. The analysis follows the five key areas introduced in the methodology: learning objectives, content progression, active learning, feedback systems, and theoretical alignment.

5.1 Case 1: AWS Academy Cloud Foundations

The AWS Academy Cloud Foundations course, a widely recognized cloud literacy program developed by AWS in collaboration with higher education institutions, offers a structured and vendor-aligned curriculum designed to introduce students to core cloud concepts and foundational AWS services. The course is organized into clear, module-by-module learning outcomes, which progressively build from fundamental topics such as compute, storage, and networking to more advanced concepts such as security and billing, aligning with Bloom's Taxonomy and advancing students' learning from knowledge to comprehension and application [5]. Active learning strategies are incorporated through hands-on labs using AWS Cloud Lab, where students engage in guided activities within sandbox accounts, reflecting Gagné's principle of guided practice [6]. While the course includes formative assessments, auto-graded quizzes, and final certification, the feedback provided is predominantly automated, lacking a personalized touch. Though the course is content-rich and well-structured, its focus remains heavily on tool usage and vendor-specific guidelines, with limited integration of deliberate instructional design principles. Consequently, while the AWS Academy offers a robust technical learning path, it could benefit from greater support for diverse learners and enhanced opportunities for reflective thinking.

5.2 Case 2: Google Cloud Skills Boost

Google Cloud Skills Boost is an open-access, modular platform that enables users to pursue learning paths across a range of topics such as infrastructure, machine learning, and Kubernetes, catering to learners from beginners to professionals. The platform's learning paths are flexible and categorized by skill level (e.g., beginner, intermediate, advanced), which allows for learner autonomy but also places significant responsibility on learners to self-navigate, a challenge particularly for novices. Unlike traditional curricula, some of these learning paths lack clearly defined long-term learning goals. The platform incorporates active learning strategies through Qwiklabs real-time labs, offering step-by-step instructions that engage learners by allowing them to practice using actual cloud infrastructure, thus supporting experiential learning and aligning with constructionist theory. While immediate feedback is provided via auto-validation of lab tasks, there is no live instructor support or reflective learning checkpoints, and assessments tend to prioritize task completion over conceptual understanding. The platform does not explicitly adhere to formal instructional models but integrates aspects of active and self-paced learning, which works well for advanced learners, though it may hinder less experienced students due to a lack of scaffolding. In conclusion, Google Cloud Skills Boost is ideal for flexible, skill-based learning; however, it risks disengaging less confident learners who require more structured guidance.

5.3 Case 3: University of Salerno–scratch-based cloud course

A course developed at the University of Salerno [4] presents an innovative approach to teaching cloud principles to university students by incorporating Scratch-based programming and gamification techniques. The course was carefully mapped against cognitive learning levels, introducing cloud principles through storytelling and gradually progressing to hands-on digital tasks, clearly reflecting both Bloom's and Gagné's models. Active learning strategies were employed through progressive projects such as cloud resource simulations and logic puzzles, with activities designed around challenges and rewards in line with gamification principles, thereby enhancing motivation and engagement. Feedback was formative, timely, and teacher-guided, and the course incorporated reflection points and peer evaluation, supporting metacognition, which is essential for deeper learning. Of the three cases discussed, this course most explicitly applied instructional design theory, adapting traditional frameworks in an innovative way to suit the cloud-based subject. The key insight from the University of Salerno case demonstrates how theory-driven course design can significantly enhance student motivation and conceptual understanding, even in technical subjects as demonstrated in Table 1.

Table 1. Comparative analysis of cloud learning platforms and academic instruction

Feature	AWS Academy	Google Cloud Skills Boost	University of Salerno
Objectives	Clear and structured	Flexible, not always clear	Clearly aligned with theory
Learning Path	Linear and vendor-guided	Modular and user-chosen	Progressive and teacher-guided
Active Learning	Hands-on labs	Real-time labs	Project-based, gamified
Feedback	Automated quizzes	Auto-validation	Teacher + peer feedback
Theory Application	Implicit structure	Minimal	Strong instructional alignment

5.4 Thematic discussion

These case studies demonstrate how different platforms and institutions approach cloud computing education. While technical engagement is high in all three, only the university case fully aligns with instructional theory. This confirms the literature findings that many online technical courses prioritize content delivery over learning process design [4], [14]. A key insight is that modular platforms, though scalable, often lack support and structure for diverse learners. Without clear learning paths and formative feedback, students may complete tasks without developing deeper understanding. The University of Salerno case proves that it is possible to blend theory and practice, even in a technical subject, by applying educational frameworks. The findings support earlier claims by Erdemir [3] and Zhang et al. [7]

that pedagogy must drive technology, not the other way around. The absence of live guidance, reflective tasks, and adaptive scaffolding in many vendor-based platforms limits their educational value for long-term skill retention.

5.5 Recommendations and proposed framework

Based on the analysis of three representative cases AWS academy, Google Cloud Skills Boost, and the University of Salerno cloud course this section presents practical recommendations and a simple theoretical framework for designing effective online learning paths in cloud computing education. The recommendations are intended for use by instructors, course designers, university curriculum committees, and edtech providers involved in technical online education.

Start with instructional design principles. Courses should begin with clear, theory-aligned learning objectives. Using frameworks such as Bloom's Taxonomy ensures that students progress from basic understanding to higher-order thinking, such as analysis, evaluation, and creation [5]. These objectives should guide both content sequencing and assessment design.

Implement scaffolded learning paths. Cloud computing courses should adopt a layered structure, where content builds progressively. Each module should prepare learners for the next, using pre-assessments, formative feedback, and summary tasks. Following Gagné's Nine Events of Instruction helps keep students focused, supported, and engaged [6].

Balance flexibility with structure. While modular and self-paced learning appeals to many, too much freedom without guidance can cause confusion. Instructors should balance flexibility with recommended pathways, optional enrichment, and learning checkpoints. For example, beginner, intermediate, and advanced tracks can be offered within the same course, but with suggested sequences.

Enhance feedback and reflection. Automated feedback is helpful but insufficient. Course designers should incorporate teacher or peer-based feedback, open reflection prompts, and revision opportunities to support deep learning. These elements also support student self-regulation and motivation [17]. To support all types of learners and accommodate diverse technical backgrounds, courses should include introductory modules, visual aids, simplified labs, and glossary tools. Diversity in activities (videos, case tasks, and coding challenges) caters to different learning styles.

5.6 Proposed framework for online cloud course design

Drawing from the literature and case findings, the following 5-stage instructional design framework is proposed as demonstrated in Table 2:

Table 2. Five stages of instructional design for technology-enhanced learning

Stage	Description
1. Define	Establish clear learning outcomes using Bloom's taxonomy levels
2. Design	Structure content with Gagné's events: gain attention, present content, guide learning
3. Deliver	Use diverse tools: videos, hands-on labs, quizzes, group tasks
4. Support	Add scaffolding, peer forums, live help, and guided feedback
5. Reflect	Integrate post-module reflections, self-checks, and discussion summaries

Because the study focuses only on cloud computing, results may not fully apply to other technical fields such as cybersecurity, software development, or data science, even though some overlap exists. Despite these limitations, the research will still offer valuable findings that can inform future teaching, course development, and research in technical online education.

5.7 Scope for future research

This study opens several promising avenues for future investigation, each offering the potential to deepen our understanding of instructional design in cloud computing education. First, comparative studies across disciplines could explore the design of learning paths in cloud computing relative to other technical fields such as data science or artificial intelligence, thereby uncovering both shared pedagogical principles and domain-specific variations. Second, longitudinal studies tracking learners over multiple semesters could provide valuable insights into the long-term effects of learning path design on knowledge retention, certification completion rates, and career preparedness. Third, experimental research involving controlled interventions may be employed to evaluate the effectiveness of specific instructional strategies or course design models, with measurable outcomes such as learner engagement, satisfaction, and academic performance. Lastly, incorporating cross-cultural perspectives by analyzing institutions across diverse geographical and educational contexts could illuminate the influence of regional pedagogical traditions, cultural expectations, and infrastructural constraints on the design and success of online learning environments. Collectively, these future directions offer a robust foundation for advancing both theory and practice in technology-enhanced education.

6 CONCLUSION

Learning cloud computing online is becoming more common, but many courses focus too much on technical skills and not enough on good teaching methods. This paper looked at three different ways these courses are taught—through AWS Academy, Google Cloud Skills Boost, and a university course from Italy. Each one had strengths, but the university course stood out because it used proven teaching strategies, such as breaking lessons into clear steps and giving students chances to reflect on what they learned.

The research shows that the best online courses should:

1. Have clear goals so students know what they are working toward.
2. Build skills step by step instead of jumping into advanced topics too fast.
3. Include hands on practice but also ways for students to get feedback and ask questions.
4. Make sure lessons fit different learning styles, not just memorizing facts.

The study suggests a simple five-step plan to help instructors design better courses. The key idea is that good teaching matters just as much as the technical content. If schools and training programs follow these ideas, students will learn more effectively and be better prepared for real-world work. There's still more to explore—such as how these methods work for different types of learners or in different countries. But this paper is a starting point for making cloud computing education more practical, engaging, and useful for everyone.

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