Service-Oriented Architecture: Learning with Generative AI and AWS

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Abstract. Service-Oriented Architecture (SOA) is a key paradigm for designing scalable, modular, and efficient cloud solutions. As cloud computing adoption grows, training professionals in cloud service architectures is essential. This paper presents an **innovative educational approach** that fully covers the learning objectives of a cloud computing course: —*Introduction to Cloud Service Architecture, Storage Services, Compute Services, Database Services, and Architectural Case Studies* while leveraging cloud computing such as **Amazon Web Services (AWS) and Generative Artificial Intelligence (AI)** to improve learning outcomes. By integrating **Generative AI tools** —such as **ChatGPT, Gemini, Perplexity, and Copilot** - students generate, validate and **analyze custom cloud computing case studies**, making the learning process more **interactive, adaptive, and aligned with industry standards**. This approach ensures that students develop both **theoretical knowledge** and **practical expertise**, enabling them to design and deploy real-world cloud architectures while acquiring the skills to become certified as AWS Solution Architects. In addition, it improves student motivation and accelerates their transition to professional cloud roles by making learning more dynamic and efficient.

Keywords: Generative AI in Education· Service-Oriented Architecture (SOA)· AWS Solutions Architect · Cloud Computing

1 Introduction

Service-Oriented Architecture (SOA) is a key paradigm in modern cloud computing, enabling scalable, modular, and reusable services [3]. As cloud platforms such as Amazon Web Services (AWS) gain widespread adoption, understanding SOA principles and native cloud architectures is essential for professionals and students alike [4]. However, effective cloud computing education remains challenging, requiring both theoretical knowledge and hands-on experience with distributed systems, high availability, and platform-specific best practices [2].

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This paper introduces an innovative approach to teaching SOA by integrating cloud computing concepts, as SOA underpins many cloud services. The course is structured around core topics:

1. **Introduction to Cloud Service Architecture:** Fundamental concepts of cloud computing and service-oriented architectures.
2. **Storage Services:** Distributed storage systems, scalability, and read and write consistency.
3. **Compute Services:** Virtualized cloud computing, scaling, fault tolerance, and high availability.
4. **Database Services:** Management of relational and non-relational databases. Scalability and high availability.
5. **Architectural Case Studies:** Case-based learning to apply knowledge in real-world cloud scenarios.

A key innovation in this approach is the use of Generative AI tools - such as ChatGPT[12], [13], Perplexity [14], or Copilot [15] to create and validate cloud computing case studies. Students generate exam-like scenarios using AI, which are refined through cross-model verification to ensure accuracy. Previous research highlights the role of AI in improving education, particularly in STEM fields [5]. This AI-assisted approach fosters engagement, curiosity, and critical thinking while accelerating skill development. In addition, aligning the course with the AWS certification standards [1] enhances its relevance in the industry, better preparing students for professional roles.

The paper is structured as follows. Section 2 reviews related work on cloud education and AI-driven learning. Section 3 details course design, modular structure, and AI-driven case study generation. Section 4 presents implementation details and results, including student performance analysis. Section 5 concludes with future directions for AI-enhanced cloud computing education.

2 Related Work

This section reviews educational approaches for teaching cloud computing, AI-driven learning methodologies, and their comparison with traditional courses. It also discusses AWS certification-based learning frameworks.

2.1 Cloud Computing Education

Traditional cloud computing education combines theoretical lectures, hands-on labs, and case studies. Although effective, these methods often lack dynamism and personalization. Armbrust et al. [2] highlighted the need for practical experience in cloud education, while Kratzke and Quint [4] emphasized understanding native cloud applications.

Correia [6] explored the integration of AWS educational materials into university curricula, focusing on official AWS content but not Generative AI tools,

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a key differentiator in our approach. Similarly, Almotiry et al. [7] studied hybrid cloud architectures for educational institutions, focusing on infrastructure deployment rather than native cloud architectures and SOA principles, which our work aims to address.

2.2 AI-Driven Learning Methodologies

AI integration in education has shown promise, particularly in personalized learning and adaptive feedback [5]. AI-powered tutoring and content generation improve engagement and accelerate learning. However, applying Generative AI to cloud computing education remains an emerging field.

2.3 AWS Certification-Based Learning

AWS certifications serve as industry benchmarks, and aligning educational programs with them improves career readiness [1]. However, certification-focused learning alone may not provide a deep architectural understanding. Our approach integrates AWS certification content within a broader SOA framework, leveraging AI to generate practical, real-world scenarios.

3 Course Design and Methodology

3.1 Learning Objectives of course

The primary objective of this course is to establish a strong foundational and conceptual understanding of cloud computing and application architecture. To achieve this, the course is structured around five key learning objectives. Introduction to Cloud Service Architecture, Storage Services, Compute Services, Database Services, and Architectural Case Studies. By covering these essential components, students will develop the ability to analyze and design cloud-based solutions effectively. Moreover, this foundational knowledge will enable them to easily extrapolate concepts and apply their learning across different cloud platforms, such as Google Cloud and Microsoft Azure, as well as in on-premise and hybrid cloud environments. This adaptability ensures that students not only grasp the core principles of cloud computing but also gain the flexibility to navigate and integrate diverse cloud architectures throughout their careers.

3.2 Course Structure

The course is structured around four key topics, which align with the core topics introduced earlier. In the following, we describe how these topics are developed using AWS as a reference. **Fig. 1** depicts the relationship.

1. **Introduction to Cloud Service Architecture:** Covers fundamental cloud concepts, key services, and architecture deployment in regions of high availability distributed worldwide. The AWS Cloud Practitioner certification [28] syllabus and exam questions serve as a reference.

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2. **Storage Services (Simple Storage Service - S3):** Explores the architecture of distributed storage systems, their applications, and the challenges of scalable and distributed architectures.
3. **Compute Services (Elastic Compute Cloud - EC2):** Focuses on managing virtualized computing systems in the cloud to execute applications in a scalable, fault-tolerant, and highly available manner.
4. **Database Services (Relational Database Service - RDS), Integration, and Serverless:** Covers database management, high-availability and scalable solutions, and serverless technologies.

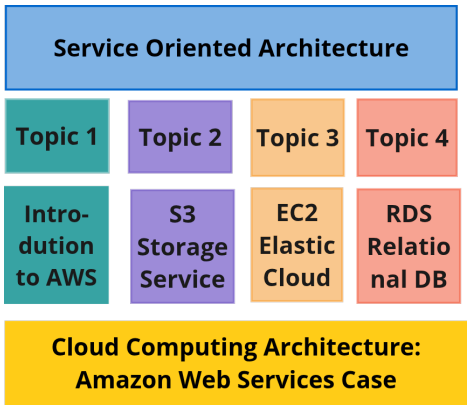

Fig. 1. Course topics related to Cloud Computing Amazon Web Services (AWS) case

This approach helps students understand service-oriented cloud architectures, including infrastructure, platform, and managed services (IaaS, PaaS, SaaS), and how these services are used for developing and deploying highly available and scalable applications. In addition, students are motivated to gain key knowledge for AWS certification, enhancing their employability.

3.3 Course Structure and Methodology

This course follows a structured, hands-on approach to cloud computing and SOA, integrating Generative AI to enhance learning. The key components include:

1. **Guided Study:** Students access AWS documentation [8] and curated videos covering cloud concepts.
2. **Cloud Practice:** Hands-on labs using the AWS console [9], AWS Command Line Interface (CLI) [10], and SDKs [11] reinforce theoretical knowledge.
3. **Case Resolution:** Students solve topic-based cases, generating new ones using AI tools (ChatGPT [12], Gemini [13], etc.), validated through cross-model verification to ensure accuracy.

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4. **Evaluation:** Topic tests are conducted using Quizizz [16], providing instant feedback and tracking progress.

This model bridges theory and practice, preparing students for certification and industry challenges while fostering critical thinking.

Laboratories Each topic includes hands-on labs structured as follows:

- **AWS CLI and SDKs:** Students configure AWS CLI [10] and use the AWS SDK with Python [11] for programmatic interactions, automating tasks, and managing resources.
- **S3 and Data Analytics:** Labs cover S3 [17], static website hosting, CloudFront [18], Route 53 [19], and data analysis with Athena [20] and Glue [21].
- **EC2, Elasticity, and Serverless:** Focus on EC2 [22], scaling, fault tolerance, high availability, load balancing, and AWS Lambda [23] for serverless execution.
- **Databases and Web APIs:** Students work with relational (RDS [24], Aurora [25]) and NoSQL (DynamoDB [26]) databases, implementing web APIs for data interactions.

Evaluation The course evaluation employs a two-tiered examination structure designed to assess both topic-specific mastery and comprehensive understanding of the material:

- **Thematic Assessments:** Conducted after each topic, these assessments apply learned concepts through case studies.
- **Integrative Exams:** Two exams are administered: the first covers Topics 1 and 2, while the final is comprehensive, evaluating knowledge synthesis across all topics.

Fig. 2 illustrates the process followed by professors and students for teaching, learning, and evaluation using Generative AI.

The process follows these key steps:

1. **Initial Case Studies:** Each student group receives three real AWS certification case studies as a reference.
2. **AI-Driven Case Generation:** Students use Generative AI tools such as ChatGPT [12], Gemini [13], Perplexity [14], or Copilot [15] to generate ten new case studies, following structured prompts to ensure relevance and complexity.
3. **Cross-Model Validation:** Generated cases are validated using an alternative AI model to ensure accuracy and mitigate hallucinations.
4. **Submission and Review:** Students submit validated cases via Google Forms [27], facilitating streamlined import and instructor review.
5. **Case Selection and Filtering:** The instructor selects high-quality cases, removing redundant or irrelevant ones to ensure alignment with learning objectives.

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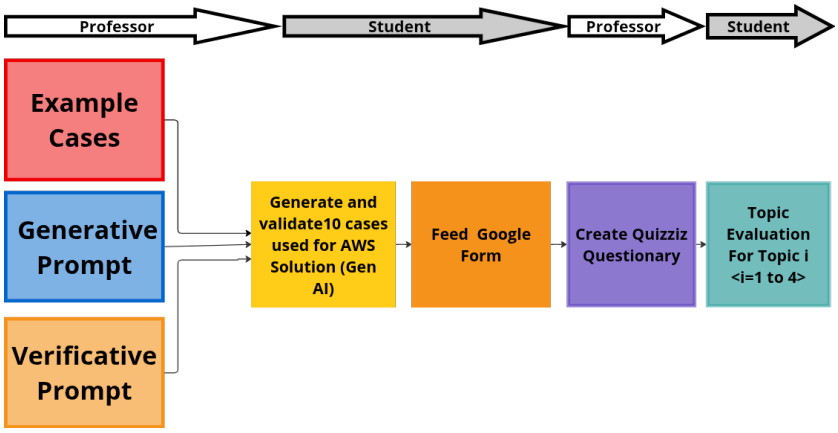

Fig. 2. Process to teach and learn each topic using Generative AI

6. **Quiz Integration:** Approved cases are converted into multiple-choice questions and integrated into Quizizz [16] for interactive assessments with immediate feedback.

3.4 Integration of Generative AI

Generative AI enhances case study creation and validation in our learning process. Students receive example case studies and structured prompts for each topic, guiding their AI tool usage. These prompts generate relevant case studies while providing a critical evaluation framework.

Example prompts:

- **Case Generation (Topic 2 - S3 Example):**
  As an AWS certified solution architect, generate ten AWS exam scenarios using Amazon S3, each with question, answer, and detailed explanation covering object storage and security.
- **Case Validation (Topic 2 - S3 Example):**
  Evaluate case study clarity, relevance, and difficulty. Verify answer correctness and explanation accuracy, identifying potential issues.

These prompts develop prompt engineering skills and critical thinking through AI-generated content evaluation.

4 Implementation and Results

The proposed methodology was implemented in a course with 24 students, divided into six groups. Students primarily utilized generative AI tools including ChatGPT, Perplexity, and Copilot for case study generation and validation, with

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ChatGPT being the most frequently preferred option based on informal observations. While formal data on tool preference was not systematically collected in this implementation, the variety of AI platforms provided students with multiple approaches to engage with the course material.

Assessments included approximately 50 questions per topic, with about 10 questions removed during refinement due to redundancy. The results demonstrated significant improvements in both student participation and performance: a 12% increase in class attendance and complete, timely submission of all course activities. The methodology received positive feedback from participants, reflected in the average course evaluation score improvement from 4.10 to 4.25 (on a 5-point scale).

5 Conclusions and Future Work

This study presented an innovative approach to teaching Service-Oriented Architecture (SOA) and cloud computing by integrating Amazon Web Services (AWS) with Generative AI tools. Our methodology successfully enhanced student engagement, motivation, and learning outcomes through a combination of AI-powered content generation and practical cloud design exercises. The implementation demonstrated measurable improvements, including increased class attendance and higher course satisfaction scores.

For future work, we plan to expand this research in three key directions: (1) automating the case study validation process to ensure higher quality outputs, (2) developing AI-driven customized lab exercises that adapt to individual student needs, and (3) implementing systematic evaluation of different Generative AI tools (ChatGPT, Perplexity, and Copilot) to assess their comparative effectiveness in generating accurate, non-hallucinated case studies. This automated evaluation framework will help identify which AI models produce the most reliable educational content while minimizing factual inaccuracies. These refinements will further optimize the methodology to bridge the gap between academic training and professional cloud computing roles.

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