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Design Thinking Engineering Learning on Cloud Ecosystem Model to Enhance Digital Intelligence for Undergraduate Student

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Abstract

This article aims to present a new educational model that integrates engineering learning with design thinking via a cloud ecosystem to enhance digital intelligence for undergraduate students. This approach utilizes user-centered problem-solving to foster innovation and collaborative learning. The educational environment can adapt to 21st-century challenges by leveraging technology and empowering students to engage confidently with various digital tools and platforms. This model promotes digital and emotional intelligence in digital interactions, essential for modern workplace success. The effectiveness of this learning model has been assessed through structured evaluations that highlight its potential to transform traditional learning methods and prepare students for the technological landscape of the future.

Keywords: engineering learning, design thinking, cloud ecosystem, digital intelligence

1. Introduction

In the digital era, education and learning have been profoundly influenced by technological advancements. The learning process has evolved and adapted to meet new demands and challenges. The integration of Information and Communication Technology (ICT) into education has catalyzed deep transformations, not just in engineering fields, but across all disciplines. The Cloud Ecosystem is a pivotal tool enhancing learning today, offering students in all fields convenient and rapid access to diverse educational resources. It also allows for the customization of learning experiences to fit the specific needs and contexts of students, fostering flexibility in educational approaches (Kovaliuk, & Kobets, 2021; Sarıtaş, 2015). Furthermore, cloud ecosystems support collaborative learning and teamwork through online tools, enhancing vital skills for the digital workplace (Chatwattana, 2018; Sharma & Kumar, 2017).

Engineering learning processes and Design Thinking are two widely recognized and applied methodologies across various disciplines, aimed at developing problem-solving, innovation, and analytical thinking skills. Engineering learning emphasizes systematic analysis and problem resolution, while Design Thinking focuses on user-centric problem solutions. The integration of these methodologies enables students from any discipline to apply knowledge and skills to solve complex problems in diverse environments (Pusca & Northwood, 2018; Lin et al., 2021). This blend of engineering processes and design thinking enables students to generate innovative ideas and develop prototypes that can be continuously tested and refined, a crucial step in preparing for the practical application of their knowledge in the real world (Taratoukhine & Pulyavina, 2018).

The integration of engineering learning processes and Design Thinking applied across disciplines via cloud ecosystems has the potential to enhance students' Digital Intelligence. This encompasses skills in digital technology usage, analytical thinking, problem-solving, and decision-making within a digital context. Students trained in this manner are well-prepared to confidently and effectively face the challenges and opportunities of the digital world (Satpathy et al., 2020; Benita et al., 2021; Indriasari et al., 2022). Furthermore, this educational approach promotes collaboration and knowledge sharing among students, skills that are essential for working and thriving in a globally interconnected digital society (Bygstad et al., 2022; Ahmed et al., 2018).

The tools for learning are designed using cloud ecosystem technologies, as they offer a diverse array of learning resources that are collaborative and adaptable to the context of each learning stage. This ensures that activities align with educational goals and the dynamics of the curriculum. Utilizing cloud-based tools promotes digital intelligence in aspects of digital literacy and emotional expression among learners, aligning with 21st-century educational development goals and digital strategies aimed at nurturing creativity and savvy use of digital technologies, suitable for today's technological environment.

2. Objective

To develop a Design Thinking Engineering Learning on Cloud Ecosystem Model to Enhance Digital Intelligence for Undergraduate Students.

To assess the suitability of Design Thinking Engineering Learning on Cloud Ecosystem Model to Enhance Digital Intelligence for Undergraduate Students.

3. Literature Review

3.1 Engineering Learning:

Engineering learning is a process that emphasizes critical thinking and problem solving, which is consistent with engineering principles, focusing on creating products or systems that are efficient and of the highest quality within a given scope. In addition, engineering learning requires a process of retrospective and iterative learning to develop solutions to complex problems through the application of basic natural principles (Davenport Huyer, et al., 2018; Kuo et al., 2021). The research of Brunhaver et al. (2017) highlights the importance of continuous reflection and iteration in engineering learning processes, enhancing the ability to develop effective engineering solutions. The research of Lynch et al. (2021) also showed that reflective practice in engineering learning allows students to continuously improve and modify their problem-solving approaches.

In the study, engineering learning does not only focus on theory but also combines practical training to enable students to apply their knowledge to real-world problems. The research indicated that engineering learning that encourages serious problem-solving will enhance students' intellectual and practical skills (Sola et al., 2017; McCrum, 2016). The research of Maha et al. (2021) and Elaby et al. (2022) explored how learning through hands-on problem-solving focused on this method can develop practical engineering skills. emphasized the importance of design thinking in engineering learning. This emphasizes the design of products that meet the needs of society. In addition, Palacin-Silva et al. (2017) research also emphasizes the development of engineering students' skills and confidence in their abilities through a learning process with continuous support and feedback.

3.2 Design Thinking

Design thinking is a collaborative, interdisciplinary, and human-centered approach that emphasizes creating products, services, or experiences tailored to user needs. This method incorporates visualization and creativity, which are recognized as essential for both business and management, as they promote innovation and provide a competitive edge. By focusing on problem-solving and action-oriented approaches, Design Thinking enables businesses to identify emerging market needs and adapt effectively. It also supports iterative testing and refinement of ideas, enhancing innovation across various sectors such as technology, healthcare, and education Silva & Marques, 2020; Caiado & Springer, 2022; Lake et al., 2019).

In education, Design Thinking plays a crucial role in developing 21st-century skills, including creativity, collaboration, and critical thinking. By fostering a mindset of experimentation and exploration, it encourages students to apply innovative solutions to real-world problems. Incorporating Design Thinking into the curriculum helps prepare students for the challenges of the modern world by promoting a culture of creativity and innovation. This educational approach equips learners with the ability to tackle complex issues, making them more adaptable to the evolving demands of today's work environment (Thornhill-Miller et al., 2023; Lin et al., 2020; Retna, 2019). Creative, problem-solving, and user-focused approaches are combined in Design Thinking to create innovative solutions across various industries, including business, engineering, technology, and education.

3.3 Cloud Ecosystem

Today, the cloud ecosystem has become very important for teaching and learning management in educational institutions. Teachers can no longer manage their classrooms effectively without the use of digital tools. In particular, cloud computing tools have become a key part of providing students and teachers with convenient access to resources and interactive learning activities (Khedr & Idrees, 2017; Chang et al., 2018; Kraleva et al., 2019; Castillo Sequera & Luna Encalada, 2017). The research shows that using cloud computing in the classroom not only saves costs but also improves the efficiency of content management and collaborative learning through flexible tools (Al-Samarraie & Saeed, 2018; Wu & Plakhtii, 2021). Similarly, Srikan et al. (2021) research indicates that the cloud also promotes the development of collaboration and problem-solving skills through online learning, especially during pandemics such as COVID-19. Cloud connectivity allows students and teachers to communicate and learn even in challenging situations.

In addition, Gupta et al. (2022) research indicates that the introduction of cloud technologies in education systems plays an important role in developing the resilience and adaptability of learning systems during emergencies. Similarly, Evans (2020) emphasizes the importance of using digital cloud tools to maintain learning continuity during school closures due to the pandemic. These studies are consistent with Barak (2017) and Çakiroğlu & Erdemir (2019) who mentioned the effectiveness of cloud systems in promoting collaboration, communication, and online learning that can respond to rapidly changing needs in digital age. The development of cloud technology not only helps in collaborative learning but also supports the efficient management of resources and data, allowing teaching and learning to continue without interruption.

3.4 Digital Intelligence

Digital intelligence, first defined by the DQ Institute in 2016, encompasses the social, emotional, and cognitive abilities necessary for individuals to navigate digital life. This framework includes skills like digital literacy, online safety, digital empathy, and ethical behavior in online environments. Studies have shown that Digital Intelligence is not just about technological proficiency, but also about how individuals engage with digital content and manage their social interactions within digital platforms (DQ Institute, 2016; Avci & Adiguzel, 2020; Yue et al., 2021). For example, Emphasize the importance of social and emotional competencies in digital spaces, as these abilities are crucial for students' personal development and for fostering positive online behaviors. Research shows that incorporating Digital Intelligence into educational curricula helps develop critical thinking, ethical decision-making, and emotional regulation in digital contexts (Bravo et al., 2021; Boughzala et al., 2020).

Furthermore, the role of Digital Intelligence in education is closely tied to improved academic outcomes and social behavior. Studies such as those by Abbas et al. (2019) and Blau et al. (2020) suggest that students with higher levels of Digital Intelligence not only perform better academically but are also more adept at collaborative learning and communication. This aligns with findings that argue that Digital Intelligence also enhances emotional intelligence in online environments, promoting positive digital citizenship and reducing negative behaviors like cyberbullying. As digital learning becomes more prevalent, fostering Digital Intelligence among students is essential for preparing them for both academic and personal success in a digital world (Intarong & Mangkhang, 2021; Maliki & Bahari, 2023).

4. Research Methodology

This research encompasses a thorough review and analysis of documents and studies related to the components of engineering learning and design thinking. This analysis serves as the foundational step in Design Thinking Engineering Learning on Cloud Ecosystem Model to Enhance Digital Intelligence for Undergraduate Student. Consequently, the study involves reviewing the literature, formulating a learning model, and assessing the suitability of this model within a cloud ecosystem to boost digital intelligence for undergraduate students. The evaluation was carried out by seven experts specialized in design thinking educational management, engineering process learning management, cloud technology, and digital intelligence skills. As previously mentioned, every expert must possess a doctoral degree and three years of relevant experience. With details as follows:

4.1 Document Review:

Researchers will analyze data including documents, textbooks, research papers, articles, and dissertations relevant to engineering learning, Design Thinking, and the use of cloud ecosystems for learning management. The review process considers the credibility and completeness of the sources, ensuring they are from reputable publishers with clear publication details.

4.2 Development of the Learning Model Based on the Literature Review

Researchers will design a Design Thinking Engineering Learning on cloud ecosystem Model to enhance Digital Intelligence for Undergraduate Students. The model will consist of four main components: input factors, learning processes, assessment, and feedback.

4.3 Evaluation of Suitability

The suitability of the developed learning model will be evaluated using a structured assessment tool. Seven experts in fields related to information and communication technology for education, educational technology, computer science, educational measurement, and evaluation will assess the model. This expert evaluation ensures the model's relevance and effectiveness in enhancing the digital capabilities of students.

5. Results

Development of Design Thinking Engineering Learning on Cloud Ecosystem Model to Enhance Digital Intelligence for Undergraduate Students is composed of four parts:

Input Factors: This includes 1) Learning objectives, 2) Learning content, 3) Learners, 4) Instructors, and 5) Cloud ecosystem.

Learning Process: This involves 1) Data synthesis phase, 2) Ideation phase, 3) Prototyping phase, 4) Performance evaluation phase, and 5) Dissemination phase.

Assessment: This includes 1) Digital literacy, and 2) Intelligent emotional expression in the digital world.

Feedback: The final process involves returning assessment results to improve the input data and process and ensure accurate evaluation outcomes. These components are illustrated in Figure 1.

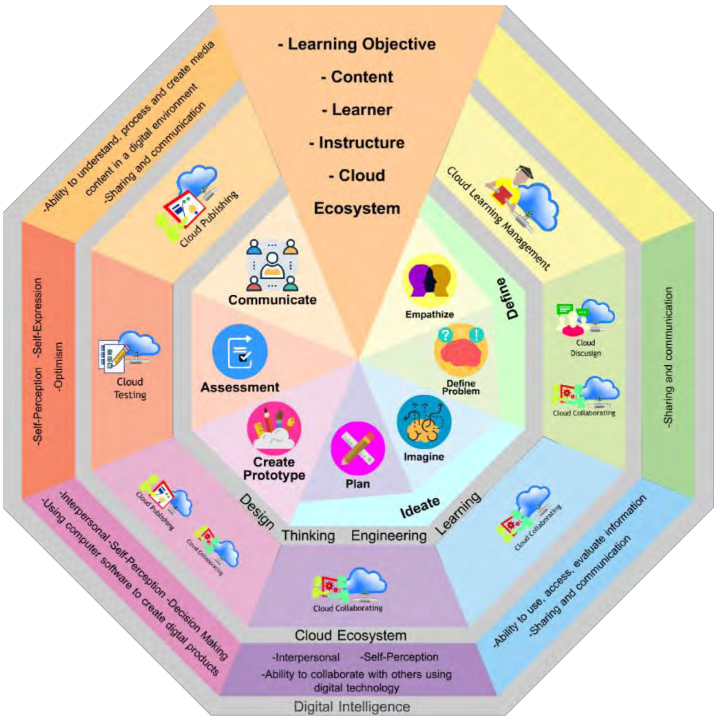

Figure 1. Design Thinking Engineering Learning on Cloud Ecosystem Model to Enhance Digital Intelligence for Undergraduate Student

Model Description The model consists of four parts: Input Factors, Learning Processes, Assessment, and Feedback, detailed as follows:

5.1 Input Factors

5.1.1 Learning Objectives:

The learning objectives of this model are tailored to the subject matter being taught by the instructor and are designed to align with the engineering and design thinking learning processes, leading to outcomes like design works or innovations from the students. This is suited for subjects that involve creative problem-solving, particularly in design disciplines like product design, graphic design, media design, and service improvement in business-related subjects.

5.1.2 Learning Content:

This represents a network of digital content specific to the subject matter, organized into each lesson's content within the model's structured learning process.

5.1.3 Learners:

Students at the tertiary education level or higher are uniquely characterized by basic technological skills, the ability to use communication and technology tools, and the aptitude for choosing appropriate cloud-based learning tools.

5.1.4 Instructors:

Guides in choosing learning methods in the cloud ecosystem, with strong communication skills and proficiency in using digital learning tools, particularly those who teach subjects related to innovation and creative expression.

5.1.5 Cloud Ecosystem:

The cloud ecosystem, with its array of learning tools, holds the potential to enhance students' digital intelligence significantly. These tools, including communication, collaboration, sharing, presentation, dissemination, and evaluation, are essential for managing learning processes.

Components of the Cloud Learning System in This Model Include:

Cloud Learning Management Tools: These tools are essential for instructors to manage teaching activities. They serve as a hub for collecting lesson content and tracking student progress. Instructors can select from various cloud-based learning management tools that best suit the needs of instructors and students.

Cloud Discussing Tools: These tools facilitate exchanges and postings to share ideas and opinions, allowing learners and instructors to engage in discussions using tools they are comfortable with.

Cloud Collaborating Tools: These tools support collaborative efforts such as creating reports, compiling, and sharing data from learning activities, and presenting outcomes.

Cloud Testing Tools: These are used to assess student performances and activities involving shared feedback on those performances. Instructors can choose these tools based on the context of the assessment.

Cloud Publishing Tools: These tools come into play at the end of the learning process, where students use them to publish or present their work. This acts as a platform for sharing knowledge with others through these tools.

5.2 Learning Process

The learning process for promoting Digital Intelligence through engineering and design thinking in the cloud ecosystem is group-based, aimed at fostering interaction, ideation, and practical implementation to achieve learning objectives. This involves five stages of the learning process:

5.2.1 Define Stage:

This initial stage of learning is aimed at identifying key issues leading to the design of the output and consists of two steps:

Empathize: This first step involves the instructor defining the study topics that will lead to innovation development. During this phase, learners understand the target group by empathizing with real-life situations directly related to the task at hand. Students conduct studies with groups directly interacting with the work to grasp the issues. They need to understand the problems, needs, and emotions from true exploration, which is crucial for creating or solving anything presented in their task. Full comprehension of the target group is essential before moving on to synthesizing the data.

Define Problem: In this step, learners process the information gathered during the empathizing step. The instructor facilitates a collaborative environment using tools designed to compile issues identified. The key process of defining the problem involves students communicating, sharing ideas, and collectively analyzing the collected data. They organize the data to identify and articulate the specific issues that need resolution.

5.2.2 Ideation Stage

In this stage, learners express potential ideas for creative outputs, drawing inspiration from online electronic media and researching relevant information and other resources that can stimulate innovative design thinking. The ideation stage consists of two learning processes:

This is a stage of unrestricted brainstorming, where learners think creatively without limits to generate diverse ideas aimed at solving problems. These ideas are derived from research and data collected through internet searches. Each group of learners compiles related information, fostering an environment of creativity and innovation.

Plan: In this activity, learners collaboratively analyze the collected data. Everyone in the group seeks new ideas to meet user needs by brainstorming with peers. They select the most viable ideas and then organize them within a timed framework. Learners can propose ideas, organize them into groups, and pick and review for any additions. These ideas might be represented through drawings, text, or concept maps.

5.2.3 Create Prototype Stage

This is a collaborative effort to create prototypes, testing them with actual users to gather feedback and suggestions before finalizing the output. In this educational context, the term "prototype" refers to a consensus among group members on a concept, which is then drafted into a tangible output such as a process, method, draft, product prototype, creative work, graphic designs, 3D models, or storyboards.

5.2.4 Assessment Stage:

This process involves evaluating the group's work, discussing the design results, and opening the floor for peers to ask questions, comment, and collectively assess the work using tools on the cloud ecosystem.

5.2.5 Communication Stage:

This final stage of learning occurs when learners have consolidated feedback and evaluations and made necessary adjustments. Learners then present or publish their work to benefit others, providing opportunities for sharing and exchanging the methodologies employed.

5.3 Evaluation

After undergoing the engineering and design thinking learning process on the cloud ecosystem, the digital intelligence of learners is evaluated, including:

5.3.1 Digital Literacy

This refers to the ability of learners to find, assess, utilize, share, and create digital content using current tools, devices, and technology. It encompasses five dimensions:

5.3.1.1 Use: Involves the Practical Application of Digital Technology

Strategies: Assign project-based tasks where students use multiple applications, such as creating reports or managing team collaborations. Conduct hands-on workshops to demonstrate tool functionalities.

Tools: Productivity platforms: Microsoft Office, Google Workspace. Collaboration tools: Trello and Asana for task management.

5.3.1.2 Understand: Focuses on Comprehending How Digital Technology Works

Strategies: Provide LMS-integrated tutorials explaining the functionalities of various tools. Host seminars or webinars to demonstrate advanced technological concepts.

Tools: Online tutorials on YouTube or LMS platforms like Blackboard or Moodle. Interactive simulations like Codecademy can help you understand coding basics.

5.3.1.3 Access: Pertains to Access Digital Information Efficiently

Strategies: Incorporate exercises where learners evaluate the credibility and reliability of digital resources. Train students in advanced search techniques (e.g., Boolean operators in search engines).

Tools: Google Scholar and PubMed for academic search. Reference management tools: Zotero, Mendeley.

5.3.1.4 Create: Relates to Generating New Digital Content or Products

Strategies: Assign creative tasks, such as designing infographics, making digital portfolios, or producing videos. Encourage team-based content creation projects.

Tools: Design platforms: Canva, Adobe Creative Suite. Digital storytelling apps: Animoto, Storybird.

5.3.1.5 Communication: Concerns Effectively Communicating Using Digital Formats

Strategies: Simulate professional communication scenarios (e.g., drafting formal emails and presenting virtual pitches). Organize peer feedback sessions to refine communication skills.

Tools: Communication tools: Slack, Microsoft Teams. Video conferencing: Zoom, Google Meet.

5.3.2 Digital Emotional Intelligence

refers to expressing empathy, sorrow, agreement, disagreement, happiness, etc., to foster relationships with classmates within a cloud ecosystem. This is assessed across four dimensions as follows:

5.3.2.1 Self-perception: Evaluates One's Awareness of One's Own Emotions in Digital Interactions

Strategies: Implement reflective journaling to encourage learners to document their emotional responses to tasks. Use mood-tracking apps to help students monitor and understand their emotions over time.

Tools: Notion, Evernote for journaling. Daylio for mood tracking.

5.3.2.2 Interpersonal: Assesses Understanding and Response to Others' Emotions Online

Strategies: Conduct role-playing activities where students take on different perspectives in virtual scenarios. Organize virtual group discussions that promote empathy through collaborative problem-solving.

Tools: Brainstorming platforms: Google Jamboard, Padlet. Virtual collaboration: Microsoft Teams, Slack.

5.3.2.3 Decision Making: Measures How Emotions Influence Digital Decision-making

Strategies: Analyze case studies highlighting the emotional aspects of decision-making. Gamify decision-making scenarios to teach emotional regulation and collaboration.

Tools: Interactive tools: Kahoot for gamified quizzes. Polling apps: Mentimeter for real-time feedback.

5.3.2.4 Self-expression: Assessing Clear and Appropriate Emotional Expression Online

Strategies: Encourage students to narrate their learning journey through digital storytelling. Assign multimedia-based projects to foster creative, emotional expression.

Tools: Digital storytelling platforms: Adobe Spark, Canva. Multimedia tools: Animoto, Flipgrid.

5.4 Feedback

Feedback from the learning process includes digital literacy and emotional intelligence measures. This feedback is used to improve each stage of the learning process, which influences future teaching and learning cycles. This continuous loop of feedback and improvement ensures that the learning process remains effective and relevant to the student's needs.

5.5 Pilot Implementation

The Design Thinking Engineering Learning on Cloud Ecosystem Model was implemented with 30 undergraduate students using tools like Google Classroom, Jamboard, and Mentimeter to foster creative learning. The study showed significant improvements in digital intelligence, with scores of 80.74% for technology use, 83.89% for conceptual understanding, and 74.44% for communication skills. Emotional intelligence metrics also improved, with high self-awareness (mean = 4.11, SD = 0.57) and interpersonal skills (mean = 4.07, SD = 0.56). These findings highlight the model's effectiveness in enhancing Digital and emotional skills and preparing students for success in a collaborative, digital world.

Evaluation of the Suitability of Design Thinking Engineering Learning on Cloud Ecosystem Model to Enhance Digital Intelligence for Undergraduate Student

Table 1. Evaluation Results of the Suitability of Design Thinking Engineering Learning on Cloud Ecosystem Model to Enhance Digital Intelligence for Undergraduate Student

Evaluation Criteria	Mean $\bar{x}$	Standard Deviation (SD)	Suitability Level
5.1 Input Factors			
5.1.1 Learning Objective	5.0	0.00	Highest
5.1.2 Learning Content	5.0	0.00	Highest
5.1.3 Learner	4.9	0.38	Highest
5.1.4 Instructors	4.9	0.38	Highest
5.1.5 Cloud Ecosystem			
Cloud Learning Management	4.9	0.38	Highest
Cloud Discussing	4.9	0.38	Highest
Cloud Collaborating	5.0	0.00	Highest
Cloud Testing	4.9	0.38	Highest
Cloud Publishing	4.9	0.38	Highest
5.2 Learning Process			
5.2.1 Define			
Empathize	4.7	0.49	Highest
Define Problem	5.0	0.00	Highest
5.2.2 Ideate			
Imagine	4.9	0.38	Highest
Plan	5.0	0.00	Highest
5.2.3 Create Prototype	5.0	0.00	Highest
5.2.4 Assessment)	5.0	0.00	Highest
5.2.5 Communication	5.0	0.00	Highest
5.3 Evaluation			

5.3.1 Digital Literacy	4.7	0.49	Highest
5.3.2 Digital Emotional Intelligence	4.3	0.49	High
5.4. Feedback			
5.4.1 Digital Intelligence	4.9	0.38	Highest
Overall Average	4.87	0.24	Highest

The table above shows overwhelmingly positive evaluations across almost all criteria, indicating that the model effectively meets the educational goals of fostering digital intelligence.

• The high scores in learning objectives, content, and the cloud ecosystem tools, especially with SD values close to zero, suggest a strong consensus among evaluators about the model's effectiveness.

• The slightly lower scores in "Empathize" and "Digital Literacy" still fall within the "Highest" suitability level, highlighting areas where there might be room for minor improvements.

• The evaluation of "Digital Emotional Intelligence" is slightly lower than other dimensions, suggesting this area could benefit from further development to fully meet the student's emotional needs in digital interactions.

These results help identify strengths and potential areas for improvement within the learning model, ensuring that subsequent iterations can be refined to better serve educational objectives better.

6. Discussion

The approach to integrated learning between engineering learning and design thinking with cloud technology aims to develop students' digital skills, starting from understanding user-centered problems. Related documents and research highlight the importance of practical learning design, emphasizing input factors, learning processes, assessment, and feedback. For instance, Pilotti (2024) demonstrated the role of cloud systems in educational environments, promoting flexible and creative learning while enhancing digital and emotional intelligence, a key focus in this research aimed at developing digital skills through cloud systems to meet the demands of students in the digital age.

Furthermore, Lin et al. (2014) supported this concept by presenting evidence that cloud-based educational tools have the potential to develop digital intelligence, particularly in data verification and the use of reliable sources, which are crucial for developing analytical thinking and decision-making skills in students. This approach is consistent with Mohammad Asif's research. (2024) emphasize integrating design thinking and problem-solving in educational environments, emphasizing the importance of creativity and critical thinking in solving real-world problems.

Integrating learning between engineering education and design thinking aims to develop essential skills for students in solving problems through innovative design processes, using cloud ecosystems as tools to enhance understanding. Fauziah et al. (2024) proposed that integrating multiple learning theories, especially creative and complex problem-solving concepts, is crucial in developing engineering skills.

While the model shows significant promise, its implementation faces challenges, particularly in diverse educational settings. Variations in digital literacy among students and teachers can hinder the effective use of cloud-based tools, and limited technological infrastructure in some institutions poses accessibility issues. Integrating emotional intelligence training into traditional curricula requires support systems and evaluation frameworks that may not align with existing practice—additionally, adapting the model for different disciplines and demographics risks diluting its core objectives. Overcoming these challenges is essential to ensure the model's scalability and ability to effectively foster digital and emotional intelligence across varied academic contexts.

7. Conclusions

The study of the engineering and design thinking learning model integrated with cloud technology, aimed at enhancing digital intelligence for undergraduate students, concludes the following:

This study focused on developing a learning model that integrates engineering processes and design thinking to promote digital intelligence among undergraduate students. The proposed model emphasizes a learner-centered teaching approach, starting from a real user-based problem understanding, which allows learners to develop solutions that genuinely meet actual needs.

Experts in information technology and education evaluated the learning model's suitability, ensuring that the developed model is appropriate and practically applicable in educational settings. Moreover, the learning model focuses on developing essential digital skills for students by utilizing cloud technology, which provides a resourcerich environment with diverse learning tools.

The designed learning process has a precise sequence, starting from problem investigation, issue summarization, and information research, leading to the development of innovations that can be practically applied. This study is pivotal in developing an effective learning model that meets the needs of learners in the digital age.

Overall, the Design Thinking Engineering Learning on Cloud Ecosystem Model to Enhance Digital Intelligence for Undergraduate Students promotes digital intelligence and prepares students to face the challenges of a rapidly changing world. The model ensures students are well-prepared for future careers and societal contributions by equipping them with the necessary digital and innovative skills.

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Authors contributions

We greatly appreciate our advisors. Prof.Dr.Pallop Piriyasurawong checked, drafted, revised, read, and approved the final manuscript. Their insightful advice and steadfast support were instrumental in overcoming challenges and contributed significantly to my research capabilities and personal growth.

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Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Canadian Center of Science and Education.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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