

Designing Cocothink: A design thinking-based conceptual framework for gamified coding learning

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ABSTRACT

Coding learning and computational thinking are increasingly recognized as essential twenty-first-century skills. Coding learning still faces challenges in sustaining learner motivation, engagement, and meaningful learning experiences. This study aimed to develop Cocothink, a Design Thinking-based conceptual framework for gamified coding learning designed to transform learning into an adventure-oriented experience. The study employed a development study approach involving 118 respondents consisting of students, coding community members, teachers, and community organizers. The findings revealed that users required more interactive, exploratory, and practice-oriented learning experiences supported by challenges, rewards, and progress monitoring. These findings were translated into the Cocothink framework, which integrates motivation, exploration, challenge, reflection, reward, progress, and development. The study also produced an early-stage Minimum Viable Product (MVP) and obtained positive expert validation results. Cocothink contributes to the development of a user-centered conceptual framework for gamified coding learning based on computational thinking.

Keywords: computational thinking, gamification, coding learning, learning experience, design thinking, conceptual learning framework

INTRODUCTION

The rapid advancement of digital transformation and Artificial Intelligence (AI) has significantly increased the demand for advanced digital competencies, particularly coding and computational thinking. According to the Future of Jobs Report 2025 published by the World Economic Forum, 60% of employers expect expanding digital access to be the most transformative trend shaping the labor market through 2030, while 86% identify advances in AI and information processing as the primary drivers of changing workforce skill requirements. The report further estimates that 59% of the global workforce will require reskilling or upskilling before 2030 to remain competitive in an increasingly digital economy. Consequently, analytical thinking, technological literacy, and competencies related to AI and big data have emerged as the fastest-growing skills demanded by employers (World Economic Forum, 2025).

These developments have reinforced the importance of integrating coding and computational thinking into education as essential twenty-first-century competencies. Beyond preparing learners for technology-driven careers, coding education cultivates analytical reasoning, creativity, and systematic problem-solving abilities that are transferable across disciplines. Consistent with this perspective, the Organisation for Economic Co-operation and Development (OECD) emphasizes that AI-driven transformation requires learners not only to acquire technical knowledge but also to develop competencies in data literacy, critical thinking, problem solving, and lifelong learning (OECD, 2026). Consequently, coding education should no longer be viewed merely as a means of learning programming languages but as a pedagogical approach for developing computational thinking and broader digital competencies that enable learners to adapt to future societal and workforce demands.

Despite its growing importance, implementing coding education remains challenging. Many learners perceive coding as difficult because it requires understanding abstract concepts, logical reasoning, and iterative trial-and-error processes. These cognitive demands often reduce learners' motivation and discourage sustained engagement in learning activities. Furthermore, previous studies have consistently identified low learning motivation, limited student engagement, and inadequate learning experiences as persistent barriers to effective coding education. These findings suggest that successful coding instruction depends not only on the content being taught but also on how learning experiences are designed to sustain motivation, encourage exploration, and foster meaningful learning.

Initial findings from this study involving 118 respondents from learner and learning-support groups revealed several important tendencies. Participants demonstrated strong preferences toward practice-oriented learning experiences and perceived coding skills as important competencies for the future. Positive responses were also found toward game-like coding learning environments, including the use of rewards and learning progress systems. These findings indicate that learners require not only conceptual understanding in coding but also learning experiences that provide challenges, feedback, rewards, and continuous progress monitoring. Previous studies have demonstrated that gamification can enhance learning motivation, engagement, and learning experiences in digital learning environments. Game elements such as challenges, rewards, feedback, and progress tracking have been widely incorporated into coding education to encourage learner participation. However, these approaches primarily emphasize motivational support rather than holistic learning experience design.

Although previous studies have investigated coding education, computational thinking, and gamification extensively, these aspects have largely been examined independently rather than integrated into a user-centered conceptual framework. Moreover, few studies have transformed coding instruction into an adventure-oriented learning experience while simultaneously developing an early-stage Minimum Viable Product (MVP) to support iterative educational innovation.

Existing conceptual frameworks for coding learning mainly focus on programming concepts and the development of computational thinking. Comparatively fewer studies have integrated user needs (Dell'Era et al., 2025; Norman, 2016; Salai et al., 2021), computational thinking (Bouck et al., 2021; Choi & Chang, 2025; Irawan et al., 2024; Rothman et al., 2025; Shute et al., 2017; Triantafyllou et al., 2024), gamification (Folgeri et al., 2019; Kaimara et al., 2021; Morschheuser et al., 2017; Nah et al., 2014; Rahmahani, 2020; Sagirani et al., 2018; Sitepu et al., 2024; Zhan et al., 2022), into a unified framework developed through a human-centered Design Thinking approach. Moreover, few studies have translated such conceptual frameworks into an accompanying Minimum Viable Product (MVP) to support iterative development and future implementation. This gap highlights the need for a conceptual framework that not only teaches coding but also designs how learners experience, explore, and develop throughout the learning journey.

In response to this gap, this study developed Cocothink, a conceptual framework for gamified coding learning based on computational thinking and designed to transform learning into an adventure-oriented experience. Unlike gamification approaches that merely add game elements to learning activities, Cocothink was developed through a Design Thinking approach in which user needs, challenges, and preferences became the foundation for framework development. The resulting framework integrates seven main components: motivation, exploration, challenge, reflection, reward, progress, and development within an adventure-oriented coding learning experience.

This study focuses on developing and conducting an initial validation of a user-centered conceptual framework for coding learning. Rather than experimentally evaluating learning effectiveness, the study aims to establish a theoretically grounded framework and its accompanying Minimum Viable Product (MVP) as a foundation for future implementation and evaluation.

This study makes three main contributions. First, it develops a user-centered conceptual framework for coding learning using a Design Thinking approach. Second, it integrates computational thinking, gamification, and adventure-oriented learning experiences into a unified conceptual framework. Third, it proposes an early-stage Minimum Viable Product (MVP) as an initial representation of the framework for future implementation and evaluation.

LITERATURE REVIEW

Computational Thinking in Coding Learning

Coding learning is no longer viewed merely as the process of learning programming syntax or languages. Rather, it is increasingly recognized as a means of developing computational thinking (CT), which encompasses problem decomposition, pattern recognition, abstraction, and the systematic design of solutions (Bouck et al., 2021; Shute et al., 2017; Triantafyllou et al., 2024). Consequently, computational thinking has become one of the essential twenty-first-century competencies and has been progressively integrated into educational curricula across both formal and non-formal learning contexts.

Previous studies have consistently demonstrated that computational thinking contributes to learners' problem-solving abilities, logical reasoning, and creativity when addressing complex problems (Choi & Chang, 2025; Irawan et al., 2024; Rothman et al., 2025). Most of these studies, however, have primarily focused on instructional strategies, learning media, or improvements in programming performance as indicators of successful learning outcomes. As a result, computational thinking is generally positioned as a cognitive learning objective rather than as part of a broader learning experience. Comparatively less attention has been devoted to understanding how learners' experiences, motivation, and engagement can support the development of computational thinking through meaningful and user-centered learning processes. Therefore, there remains a need for approaches that integrate computational thinking development with richer and more engaging learning experiences.

Gamification in Coding Learning

Gamification has become one of the most widely adopted approaches for enhancing learner motivation and engagement in digital learning environments. This approach incorporates game elements such as challenges, rewards, points, levels, progress tracking, and feedback into non-game contexts, including education, to encourage active participation and sustained learning (Keandounghun et al., 2023; Sagirani et al., 2018).

Numerous studies have reported that gamification can improve learning motivation, learner participation, user engagement, and even learning retention (Morschheuser et al., 2017; Saleem et al., 2022). Within the context of coding learning, gamified

learning environments have been shown to encourage learners to complete programming exercises more actively, maintain their interest throughout the learning process, and reduce the perception that coding is inherently difficult.

Despite these benefits, existing research also suggests that many gamification implementations remain primarily focused on incorporating game elements as strategies for increasing extrinsic motivation. Consequently, these approaches often fail to transform the overall learning experience, leading learners to focus more on earning points or rewards than on developing conceptual understanding and progressively strengthening their competencies (Almeida et al., 2023). These findings indicate that the effectiveness of gamification depends not merely on the presence of game elements, but on how those elements are meaningfully integrated into a coherent and engaging learning experience.

Learning Experience and Adventure-Based Learning

Recent developments in educational innovation have highlighted that successful learning is influenced not only by the quality of instructional content but also by the quality of the learning experience perceived by learners. Learning experience encompasses how learners engage with challenges, receive feedback, reflect on their progress, and develop their competencies throughout the learning process (Ahmed Dahri et al., 2025; Hantke et al., 2018; Ofosu-Asare, 2024). Consequently, designing meaningful learning experiences has become an important consideration in creating effective and learner-centered educational environments.

One approach that supports the development of meaningful learning experiences is adventure-based learning. This approach conceptualizes learning as a journey characterized by sequential stages of exploration, challenge, achievement, reflection, and continuous competence development (González Melero, 2023). Through this perspective, learners are encouraged not only to acquire knowledge but also to actively experience the learning process in ways that promote motivation, engagement, and personal growth.

Despite its educational potential, the application of adventure-based learning in coding learning remains relatively limited. Existing studies have primarily focused on specific instructional activities or digital learning media, while comparatively little attention has been devoted to integrating adventure-based principles into the overall design of coding learning experiences. This limitation suggests the need for a more comprehensive framework that positions adventure not merely as a learning activity but as an organizing principle for designing meaningful, engaging, and user-centered coding learning.

Design Thinking in Educational Innovation

In recent years, Design Thinking has been increasingly adopted as a human-centered approach to developing educational innovations. This approach places users' needs, experiences, and challenges at the center of the design process, guiding solution development through five iterative stages: empathize, define, ideate, prototype, and test (Barnum, 2020; Dell'Era et al., 2025; Rösch et al., 2023). By emphasizing empathy, collaboration, and iterative problem-solving, Design Thinking enables educational innovations to be developed in ways that are more responsive to learners' needs and authentic educational contexts.

Unlike traditional development approaches that primarily focus on producing complete educational products, Design Thinking emphasizes iterative refinement through continuous prototyping and evaluation. Within this process, the prototype stage plays a pivotal role in translating conceptual ideas into tangible representations that can be evaluated and refined through user feedback. Rather than aiming to produce a finalized solution from the outset, the prototype serves as a medium for validating design assumptions and identifying opportunities for improvement before broader implementation.

In the context of this study, the prototype stage resulted in the development of a Minimum Viable Product (MVP) as an initial operational representation of the proposed conceptual framework. The MVP is not intended to function as a final educational product or merely as an application prototype. Instead, it represents the core mechanisms of the Cocothink conceptual framework, enabling its theoretical constructs, gamification features, and learning experience design to be visualized, subjected to initial validation, and iteratively refined. Accordingly, the MVP serves as a bridge between conceptual framework development and future implementation, providing an initial basis for evaluating and further developing the proposed coding learning platform.

Critical Synthesis and Research Gap

The literature reviewed in this study indicates that research on computational thinking, gamification, learning experience, adventure-based learning, and Design Thinking has advanced considerably in recent years. Each of these perspectives has made important contributions to improving coding learning, whether by strengthening computational thinking skills, enhancing learner motivation and engagement, or promoting more interactive and meaningful learning experiences.

Despite these advances, existing studies have generally examined these perspectives in isolation. Research on computational thinking has primarily emphasized the development of cognitive competencies, whereas gamification studies have focused predominantly on the use of game elements to increase learner motivation and engagement. Similarly, studies on learning experience and adventure-based learning have rarely been integrated into the design of coding learning, while Design Thinking has been applied more frequently to the development of educational media or products than to the development of conceptual learning frameworks. As a result, limited attention has been devoted to designing coding learning environments that integrate these complementary perspectives within a single user-centered framework.

Another limitation identified in the literature concerns the operationalization of conceptual frameworks. Many previous studies have proposed conceptual models or developed educational applications without providing an intermediate representation that enables early validation of the proposed framework before full-scale implementation. Consequently, the relationship between conceptual design and practical implementation often remains insufficiently articulated, making it difficult to evaluate whether the proposed framework effectively addresses users' needs during the early stages of development.

To address these gaps, this study develops Cocothink, a user-centered conceptual framework that integrates computational thinking, gamification, learning experience, and adventure-based learning through a Design Thinking approach. As part of the prototype stage, this study also develops a Minimum Viable Product (MVP) as an operational representation of the conceptual framework, enabling its core concepts to undergo initial validation before being further developed into a comprehensive coding learning platform. Through this approach, Cocothink contributes not only by integrating multiple educational perspectives into a unified conceptual framework but also by providing a systematic pathway from conceptual design to future implementation and evaluation.

METHODS

Research Design

This study employed a development study approach aimed at developing a conceptual learning framework for coding learning based on computational thinking and gamification. Rather than evaluating the effectiveness of an educational intervention, the study focused on designing, refining, and conducting an initial validation of a user-centered conceptual framework together with its early operational representation through a Minimum Viable Product (MVP). This approach is consistent with the characteristics of development research, which emphasizes the iterative design and conceptual validation of innovative educational solutions prior to full-scale implementation.

To achieve these objectives, the study adopted a Design Thinking approach, which places users' needs, experiences, and challenges at the center of the innovation process (Barnum, 2020; Dell'Era et al., 2025; Koh, 2015; Rösch et al., 2023). Design Thinking provides a systematic and iterative framework consisting of five stages—*empathize*, *define*, *ideate*, *prototype*, and *test*—allowing educational innovations to be progressively refined based on evidence gathered throughout the development process.

During the Empathize stage, the study identified users' needs, perceptions, challenges, and expectations regarding coding learning. The findings informed the Define stage, where the primary design problems were formulated. The Ideate stage generated the initial concepts of the Cocothink framework and its gamification structure based on the identified user needs. These concepts were subsequently translated into an early operational representation through an MVP during the Prototype stage. Finally, the Test stage involved expert validation to obtain constructive feedback for refining the proposed conceptual framework.

The outcome of this process was the Cocothink conceptual framework, which integrates motivation, exploration, challenge, reflection, reward, progress, and development within an adventure-oriented coding learning experience. Each stage of Design Thinking generated outputs that informed the subsequent stage, ensuring that the framework evolved systematically from users' needs to an initially validated conceptual model supported by an MVP representation.

Participants

Participants in the empathize stage were selected using purposive sampling based on characteristics relevant to coding learning contexts. Data collection was conducted through direct interviews and online questionnaires distributed via Google Forms over approximately three to four weeks.

Participants consisted of two main groups:

1. User groups, including students learning Informatics or Information and Communication Technology (ICT), as well as coding community members;
2. Learning-support groups, including teachers and community organizers involved in learning facilitation and mentoring activities.

This study involved two stages of participant engagement corresponding to the Empathize phase of the Design Thinking process. The first stage consisted of semi-structured interviews with five participants representing both learner and learning-support groups. This number was considered appropriate because the objective of the interviews was to explore users' needs rather than to achieve statistical generalization. In exploratory qualitative research, a small purposively selected sample is considered sufficient when recurring themes begin to emerge, indicating information redundancy (Guest et al., 2006). Following the initial interviews, a questionnaire was distributed to a broader group of users to obtain a more comprehensive understanding of learners' needs, preferences, and perceptions regarding coding learning. A total of 118 valid responses meeting the inclusion criteria were included in the analysis. The sample size was not determined through statistical sample size calculation because the study was not intended to test hypotheses or produce statistically generalizable findings. Instead, the quantitative data were used to identify user needs and support design decisions during the development of the Cocothink conceptual framework. Involving participants with diverse backgrounds enabled the study to capture a broader range of perspectives on the challenges, motivations, expectations, and learning experiences associated with gamified coding learning.

Prior to data collection, the questionnaire underwent expert judgment involving three experts with expertise in educational technology, coding learning, and gamification. The validation process examined the alignment between the questionnaire items and the intended constructs, the clarity of item wording, the relevance of each question, and the adequacy of construct representation. Feedback from the experts was subsequently incorporated to refine the instrument before it was administered to participants.

Table 1. Research instruments and their purposes

Stage	Instrument	Purpose
Empathize	Need assessment questionnaire	Identifying user needs and perceptions toward coding learning
	Empathy map	Understanding user experiences and characteristics
	User persona	Describing user profiles
	User journey map	Mapping user learning journeys
Define	Root cause analysis and HMW	Identifying problems and development opportunities
Test	Expert validation instrument	Evaluate the Cocothink conceptual framework and provide recommendations for its refinement.

Table 2. Design thinking stages in Cocothink development

Stage	Main Activities	Outputs
Empathize	Identifying user needs	Need assessment
Define	Problem analysis	Problem statement
Ideate	Concept development	Cocothink framework, gamification structure
Prototype	Initial design development	Cocothink MVP
Test	Expert validation	Framework refinement

Ethical Considerations

This study involved a minimal-risk educational needs assessment using interviews and questionnaires. Participation was voluntary, and all participants were informed about the purpose of the study before providing their consent. Participants were also informed that they could decline or withdraw from the study at any time without consequence. Participants' identities were kept anonymous, and all data were treated confidentially and used solely for research purposes. At the authors' institution, there is no research ethics committee responsible for reviewing and issuing ethical approval for non-interventional educational research. Therefore, no formal ethical approval was available for this study.

Instruments and Data Collection

Data collection employed several instruments aligned with the Design Thinking stages. During the empathize stage, data were collected through interviews using semi-structured question guidelines and online need assessment questionnaires. The questionnaires were designed to identify users' perceptions, experiences, motivations, challenges, and needs related to coding learning and gamified learning experiences. Before being administered for data collection, the questionnaire underwent an expert judgment process involving three validators with expertise in educational technology, coding education, and gamification. The purpose of this process was to evaluate the alignment of the questionnaire items with the intended constructs, the clarity of the wording, the relevance of each item, and the adequacy of the aspects represented. Feedback provided by the validators was incorporated to refine the instrument prior to its use in the user needs assessment phase.

The study also utilized supporting instruments, including empathy maps, user personas, and user journey maps to better understand user characteristics, learning contexts, and expected learning experiences.

During the define stage, the collected data were analyzed using root cause analysis and the formulation of "How Might We" (HMW) questions to identify major problems and opportunities for framework development.

The test stage employed expert validation instruments to evaluate the Cocothink framework in terms of learning content, design, and gamification aspects. Validation was conducted through assessment instruments followed by interviews to obtain deeper feedback regarding the developed framework. **Table 1** presents a summary of the research instruments and their purposes.

Development Process Using Design Thinking

The development of Cocothink was conducted through the five stages of Design Thinking.

The empathize stage focused on identifying user needs through surveys, learning experience analysis, and the development of empathy maps, user personas, and user journey maps. Findings from this stage were used to understand users' challenges, motivations, and expectations regarding coding learning.

The define stage aimed to formulate the main problems based on the identified user needs. The analysis was conducted through root cause analysis and the formulation of "How Might We" questions as the basis for solution development.

The ideate stage generated the Cocothink concept, including the transformation philosophy of "learning becomes adventure," as well as the development of the framework structure and gamification concepts.

The prototype stage translated the conceptual framework into an early-stage MVP design containing learning-support features such as challenges, rewards, progress systems, and learning progress monitoring.

The test stage involved expert validation to obtain feedback regarding the developed conceptual framework and MVP design. **Table 2** summarizes the Design Thinking development process.

Data Analysis

Quantitative data obtained from the need assessment questionnaires were analyzed using descriptive statistics in the form of mean scores to describe trends in users' perceptions and needs regarding coding learning and gamified learning experiences. The

Table 3. Summary of user needs in coding learning

Indicators	Mean
Coding is important for the future	4.10
Preference for hands-on practice	4.07
Interest in game-like learning	4.10
Need for rewards	3.46
Need for progress monitoring	3.71

Table 4. Translation of user needs into Cocothink components

User Needs	Insights	Design Decisions	Components
Coding is important, but motivation needs to be sustained	Users need goals and learning encouragement	Integrating motivational reinforcement systems	Motivation
Preference for hands-on practice	Learning should be exploratory	Exploration-based activities	Exploration
Interest in game-like learning	Challenges increase engagement	Challenges and quest systems	Challenge
Need for feedback	Reflection supports learning improvement	Feedback and evaluation systems	Reflection
Preference for rewards	Positive reinforcement sustains motivation	Rewards, badges, and EXP systems	Reward
Need for progress monitoring	Progress awareness supports continuous learning	Progress dashboard	Progress
Desire for continuous development	Learning should support ongoing growth	Advanced challenges and progression systems	Development

identified user needs were subsequently synthesized to connect user needs, insights, design decisions, and the developed Cocothink framework components.

Quantitative and qualitative data obtained from expert validation and interviews were analyzed to examine the feedback provided, the conceptual validity of the proposed framework, and recommendations for its refinement. The validation process employed a Likert-scale assessment instrument ranging from 1 to 5 to evaluate pedagogical aspects, computational thinking, learning experience, interface design, usability, and gamification structure. Each validator assessed 15 indicators according to their field of expertise and provided comments and development suggestions. Score interpretation referred to the categories of very inappropriate (1), inappropriate (2), moderately appropriate (3), appropriate (4), and highly appropriate (5). The validation results were used as the basis for refining the Cocothink conceptual framework and the MVP design. The analysis results were then used to develop the Cocothink framework and the early-stage MVP design.

The synthesis of user needs, analytical insights, and subsequent design decisions formed the basis for translating the identified needs into the core components of the Cocothink conceptual framework. The outcomes of this synthesis are presented in the Results section.

RESULTS

User Needs and Learning Challenges in Coding Learning

The need identification stage involved 118 respondents consisting of user groups and learning-support groups. The user groups included students and coding community members, while the learning-support groups consisted of teachers and community organizers. The need assessment results indicated that respondents had positive perceptions regarding the importance of coding skills and the need for more interactive and engaging learning experiences. Several major findings revealed that practice-oriented learning obtained a relatively high mean score ($M = 4.07$), followed by the perception that coding is an important skill for the future ($M = 4.10$). In addition, interest in game-like coding learning environments also received positive responses ($M = 4.10$).

Other findings showed that users required learning experiences that provided challenges, rewards, feedback, and continuous learning progress monitoring. These findings indicate that user needs are related not only to coding concept mastery but also to learning experiences that support motivation and personal development. **Table 3** presents a summary of the need assessment findings.

These findings suggest that coding learning requires approaches that are more oriented toward learning experiences, exploration, and continuous learner development.

Translating User Needs into Design Decisions

The identified user needs were subsequently translated into design decisions in the development of Cocothink. The synthesis process was conducted by connecting user needs, insights, design decisions, and the developed framework components (See **Table 4**).

The synthesis findings became the foundation for developing the Cocothink conceptual framework and its structural components.

Development of the Cocothink Concept: From Learning to Adventure

The define and ideate stages resulted in the main Cocothink concept, which aims to transform learning into an adventure-oriented experience. This concept was developed based on the understanding that coding learning should not focus solely on task

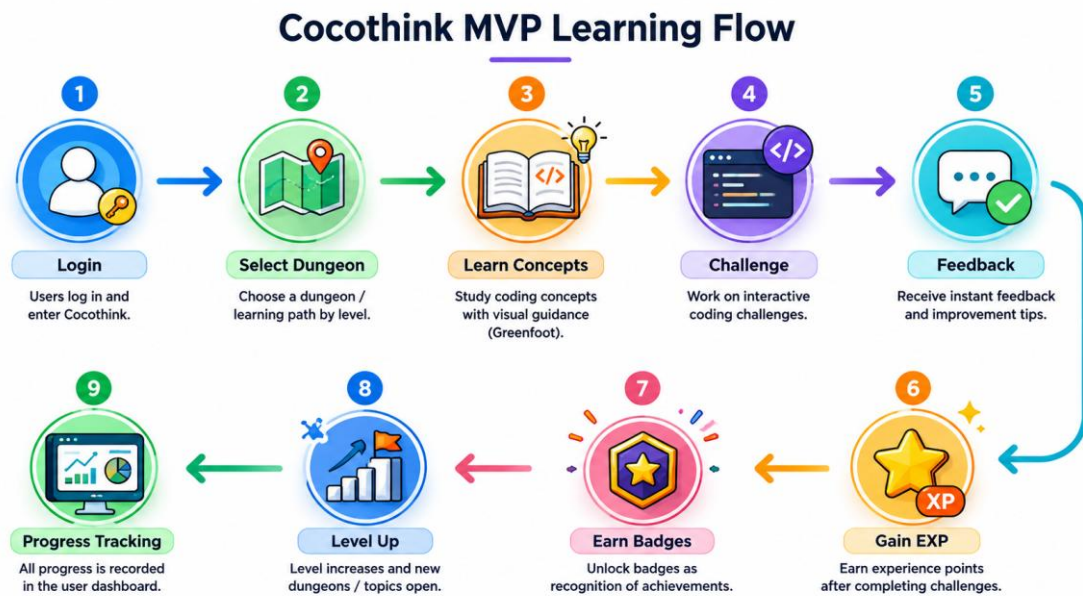


Figure 1. Cocothink MVP learning flow (Source: Authors' own elaboration)

completion or conceptual mastery but also on learners experiences throughout the learning process. Within Cocothink, learning activities are positioned as a journey involving exploration, challenges, achievements, reflection, and gradual skill development. Consequently, learners are expected not only to acquire technical competencies but also to sustain engagement and learning motivation throughout the coding learning journey.

Development of Cocothink Framework Components

The development process resulted in seven main components within the Cocothink framework. These components form an interconnected learning experience cycle:

- Motivation functions to build initial learning encouragement;
- Exploration provides opportunities to experiment and understand concepts;
- Challenge promotes engagement through tasks and mission completion;
- Reflection helps learners understand processes and learning mistakes;
- Reward provides reinforcement for achievements;
- Progress enables learners to monitor their learning development;
- Development encourages learners to pursue more advanced challenges.

The framework was developed to support coding learning experiences that emphasize continuous engagement and gradual learner development.

Development of Gamification Structure and MVP Concept

The Cocothink concept was translated into an early-stage Minimum Viable Product (MVP) design containing gamification elements that support learning experiences.

The MVP structure was designed through the following learning flow, as shown in **Figure 1**.

In addition, the MVP was designed to include learning progress monitoring features (dashboard), challenge systems, rewards, progress tracking, and gradual skill development. In this study, the MVP was positioned as an early-stage implementation representation intended to help visualize the learning experience structure, gamification flow, and user interactions within the Cocothink conceptual framework. The MVP was developed using two main platforms, Laravel and Greenfoot, to translate the gamification concept and adventure-oriented learning experience into a more concrete initial implementation.

Laravel was utilized as a web application framework to support learning platform management, including user authentication, content management, learning progress monitoring, point and level systems, certification, and game module integration. Meanwhile, Greenfoot was employed as a Java-based educational game engine that supports visual, interactive, and beginner-friendly coding learning experiences. Through Greenfoot, users are able to observe direct responses from characters and objects based on the code they write, making the coding learning process more exploratory and contextual.

The integration of these two platforms supports the development of learning experiences that focus not only on coding content delivery but also on user engagement through challenges, exploration, progress, and adventure-oriented learning experiences.

Table 5. Summary of expert validation results

Aspect	Validator	Mean Score	Category
Learning Content	Content Expert	4.4	Highly Appropriate
Design	Design Expert	4.1	Appropriate
Gamification	Gamification Expert	4.6	Highly Appropriate

**Figure 2.** The Cocothink conceptual framework (Source: Authors' own elaboration)

Test: Expert Validation Results

The test stage was conducted through validation involving three expert validators representing learning content, design, and gamification fields. The expert validation results indicated that Cocothink received positive evaluations across most indicators related to learning content, design, and gamification aspects. Validators considered that the framework has the potential to support more interactive, exploratory, and user-centered coding learning experiences. The gamification aspects and the transformation concept of “learning becomes adventure” were particularly appreciated because they were considered capable of enhancing learner engagement in coding learning.

Nevertheless, validators also provided several recommendations regarding the refinement of MVP implementation, the improvement of user interaction details, and the need for further testing in real learning contexts. **Table 5** presents the summary of expert validation results.

The validation results were used to refine the framework before producing the final Cocothink conceptual framework.

Final Cocothink Framework

The final result of this study is the Cocothink conceptual framework, a computational thinking-based and gamified coding learning framework developed through a Design Thinking approach based on user needs. **Figure 2** presents the final Cocothink conceptual framework.

The framework integrates:

1. The learning transformation philosophy: *Learning Becomes Adventure*;
2. The Cocothink framework concept consisting of motivation, exploration, challenge, reflection, reward, progress, and development;
3. The gamification structure, including challenges, feedback, EXP, badges, level progression, and progress tracking;
4. An early-stage implementation design through the Minimum Viable Product (MVP).

Thus, Cocothink is positioned as a conceptual framework that not only supports coding skill development but also seeks to create more meaningful, interactive, and user-centered learning experiences.

DISCUSSION

The findings of this study indicate that users' needs in coding learning are related not only to conceptual mastery but also to learning experiences capable of sustaining motivation, engagement, and continuous learner development. Preferences toward hands-on practice, game-like learning environments, rewards, and progress monitoring suggest that the main challenges in coding learning are associated not only with the complexity of coding materials but also with how learning experiences are designed (Choi et al., 2025; Huang & Wang, 2025; Mills et al., 2025).

Unlike gamification approaches that generally incorporate game elements merely as motivational strategies, Cocothink was developed based on user needs identified from the early stages through a Design Thinking approach. Consequently, gamification within Cocothink is positioned not as an additional feature but as part of the learning experience structure itself. This approach expands the understanding of gamification from the simple use of points or rewards toward a more holistic learning experience design (Amantay, 2022; Choi et al., 2025; Saleem et al., 2022).

The present study makes several contributions to the field of coding learning. First, from a theoretical perspective, the contribution of this study extends beyond the development of the Cocothink framework itself. It reconceptualizes coding learning as a learning experience that evolves through exploration, challenge, reflection, and the gradual development of learners' competencies. This perspective broadens the conventional view of coding learning, which has traditionally emphasized computational thinking or programming skills, by positioning coding as a learning adventure centered on users' experiences and meaningful engagement throughout the learning process.

Second, from a conceptual perspective, this study proposes a user-centered conceptual learning framework that integrates computational thinking, gamification, learning experience, adventure-based learning, and Design Thinking into a coherent framework. While previous studies have typically examined these perspectives independently or combined only a limited number of them, Cocothink demonstrates how these complementary approaches can be systematically integrated to support the design of coding learning environments that are both engaging and pedagogically meaningful.

Third, from a methodological perspective, this study demonstrates a systematic development process for translating users' needs into design decisions, framework components, and an early operational representation through a Minimum Viable Product (MVP). This process illustrates how Design Thinking can be applied as a structured approach for developing and conducting the initial validation of conceptual learning frameworks before full-scale implementation. Consequently, the development process presented in this study provides a replicable methodological reference for future research on user-centered digital learning innovation.

Overall, this study contributes to the advancement of coding learning by proposing a conceptual learning framework that integrates computational thinking, gamification, adventure-based learning, and human-centered design based on identified user needs. Beyond introducing a new conceptual framework, the study also demonstrates a systematic pathway from user needs identification to conceptual design and initial validation, thereby providing a foundation for future implementation and empirical evaluation.

Future Research

Further studies are needed to implement and evaluate the effectiveness of Cocothink in real learning environments through user testing and learning impact measurement. In addition, the current validation process remains limited to expert validators and has not yet involved broader-scale user testing.

Future research may focus on implementing Cocothink in authentic learning contexts to evaluate its influence on learner engagement, coding skills, and computational thinking development. Further development may also involve refining the MVP into a more comprehensive system, including learning analytics features, personalized learning experiences, and the integration of artificial intelligence-based technologies.

CONCLUSION

This study developed Cocothink, a conceptual learning framework for coding learning that integrates computational thinking and gamification to transform coding learning into an adventure-oriented learning experience. Developed through a Design Thinking approach grounded in users' needs, the framework integrates motivation, exploration, challenge, reflection, reward, progress, and development into a coherent structure for designing learner-centered coding experiences. The study also produced an initial operational representation of the framework through a Minimum Viable Product (MVP) to support its preliminary conceptual validation.

The contributions of this study extend beyond the development of the Cocothink framework itself. Theoretically, it reconceptualizes coding learning as an adventure-oriented learning experience that integrates computational thinking, gamification, learning experience, and human-centered design. Conceptually, it demonstrates how these complementary perspectives can be systematically integrated into a coherent conceptual learning framework based on identified user needs. Methodologically, the study presents a systematic Design Thinking process for translating user needs into design decisions, framework components, and an initial operational representation through an MVP, thereby providing a replicable approach for future user-centered learning framework development.

Despite these contributions, this study has several limitations. The research was limited to the development of the conceptual framework and its initial expert validation; therefore, it did not include implementation or evaluation with end users in authentic learning environments. Future research should implement and empirically evaluate the effectiveness of the Cocothink framework across diverse educational contexts. In addition, the current Minimum Viable Product (MVP) can be further developed into a more comprehensive digital learning platform to support broader implementation, evaluation, and continuous refinement of the framework.

Author contributions: **TS:** conceptualization, methodology, project administration, supervision; **BH:** literature review, investigation, methodology, conceptualization; **PR:** conceptualization, visualization; **MRF & DNP:** software, investigation, validation; **WWE:** data curation, formal analysis, conceptualization. All authors agreed with the results and conclusions.

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Ethical statement: The authors stated that the study involved a minimal-risk educational needs assessment using interviews and questionnaires. Participation was voluntary, and all participants were informed about the purpose of the study before providing consent. Participants' identities were kept anonymous, and all data were treated confidentially and used solely for research purposes. Formal ethical approval was not obtained because the authors' institution does not have a research ethics committee responsible for reviewing non-interventional educational research.

AI statement: The authors stated that ChatGPT was used during the preparation of this article to support brainstorming and idea development, identify potentially relevant supporting references, and assist in the visualization and creation of figures. In particular, ChatGPT was used to assist in developing the visual representations of the Cocothink MVP learning flow and conceptual framework. All AI-generated outputs were critically reviewed, revised, and validated by the authors. The authors remain fully responsible for the content, accuracy, interpretation, and conclusions presented in this article.

Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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