Imagineering Gamification Model on an Intelligent Learning Experience Management Platform

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***Abstract* – The objectives of this research include: 1) To develop the Imagineering Gamification Model on an Intelligent Learning Experience Management Platform for enhancing innovation problem solving abilities, 2) To develop the Intelligent Learning Experience Management Platform, and 3) To evaluate the innovation problem solving abilities of undergraduate students who learned through the proposed model and platform. The study was implemented with bachelor's degree students from computer-related departments selected using a simple random sampling method. The results of the research showed that the Imagineering Gamification Model on an Intelligent Learning Experience Management Platform for enhancing innovation problem solving abilities was evaluated by experts in terms of appropriateness at the highest level; the Intelligent Learning Experience Management Platform was evaluated by experts in terms of appropriateness at the highest level; and the innovation problem solving abilities of undergraduate students who learned from the proposed model and platform improved after participating in learning activities.**

DOI: 10.18421/TEM153-45
https://doi.org/10.18421/TEM153-45

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Received: 21 July 2025.
Revised: 09 February 2026.
Accepted: 27 February 2026.
Published: 27 August 2026.

***Keywords* – Imagineering, gamification, learning experience platform, intelligent platform, innovation problem solving.**

1. Introduction

The most common learning problems in learning are lack of motivation to engage and difference in background knowledge and skill. The problem of motivation lacking may come from monotonous and repetitive learning tasks leading to boredom and disengagement. For the different background knowledge issue, students in the same class may find learning content too advance or too easy as they come from different past school or course. As students' ability to comprehend new material is influenced by their existing knowledge and experiences, it is necessary to address the issue objectively for promoting engagement and academic success for all students. Furthermore, emerging technologies such as automation system, artificial intelligence, internet of things, and robotics have been significantly disrupting traditional structure and practices in many fields, especially the field of education [1], [2]. The technologies transform how students learn, teachers teach, and educational institutions operate for more inclusive, accessible, and effective learning experience. The technologies do not only change the traditional practices, but the disruption also bring new work opportunities and needs of emerging technology specialists. Thus, this leads education institutes to change and prepare their students to be sustainably ready for the disruption from emerging technologies accordingly [3], [4]. Ones of the most needed foundation and higher order skills for the readiness of technological disruption are such as problem solving, critical thinking, goal setting and decision making [5]. Furthermore, The World Government Summit (foundational skills that will help citizens thrive in the future of work) indicates that structured problem-solving skill which is a foundation cognitive skill can help citizen to achieve their success career [6].

Some research studies [7], [8] also find that critical thinking, and creative and innovation thinking are essential for tackling technological disruption.

Among many learning approaches, Imagineering and gamification are ones of effective approaches to help motivating students as well as to train for creative thinking, critical thinking, and problem-solving skills. The term 'Imagineering' is a portmanteau of the term 'imagination' and 'engineering' to reflect the interdisciplinary approach to bring imaginative concepts to life through innovative design, storytelling, and technology [9], [10]. For gamification, the goal is to incorporate elements of game design and mechanics into educational activities to enhance engagement, motivation, and learning outcomes [11], [12], [13], [14]. Gamification has been widely applied in education field since it makes learning more interactive, enjoyable, and engaging by incorporating elements of play and competition [7], [8]. Furthermore, gamification encourages the application of knowledge and skills in real-world contexts, promoting learning transfer to new situations and problem-solving skills [7], [8], [15]. To tackle knowledge background difference, one of the learning approaches called personalized learning has been applied. Personalized learning aims to tailor instruction, content, pace, and learning experiences to meet the individual needs, preferences, and interests of each student. In fact, personalized learning commonly leverages information technology and smart technology into Learning Experience Platform (LXP) to support individualized instruction and facilitate personalized learning experiences with customizable digital resources, real-time feedback, and interactive learning [16], [17], [18].

In this work, the Imagineering and gamification learning approaches are combined to improve students' motivation and engagement. In addition, a learning experience platform is developed with the help of artificial intelligence technology that support personalized learning incorporating with the combined Imagineering and gamification. The platform is expected to help improving student's motivation, supporting students with different background knowledge, and preparing students of digital and smart system literacy. The target learning skill in this work is a problem-solving skill towards programing coding for developing innovation.

2. Theoretical Background

There are three parts in this section 1) Imagineering and gamification Approach, 2) Learning Experience Platform, and 3) Problem-Solving Skills and Innovation Development.

2.1. Imagineering and Gamification Approach

The Imagineering teaching approach is one of learning schemes to draw inspiration from the principles and practices of Walt Disney Imagineering by aiming to create immersive and engaging learning experiences that spark curiosity, creativity, and collaboration among students. It promotes the use of imagine, thinking outside the box, and abstractive thinking to enhance teaching and learning environments to encourage training of complex skills for students [9], [10]. Imagineering can be applied to with other learning schemes/approaches such as gamification [19] and personalized learning to empower the benefit of increasing students' engagement. A research study signifies that the Imagineering teaching approach seeks to transform education into a dynamic and engaging journey filled with discovery and creativity for empowering students to become lifelong learners who are ready for an ever-changing world [20].

Gamification in learning refers to the integration of game design elements and principles into educational activities and processes. The common game elements applied in learning are such as points, levels, badges, leaderboards, challenges, rewards, and progression systems. Points are to measure progress or performance by completing tasks, achieving goals, or demonstrating desired behaviors. Levels represent different stages of progression within a gamified learning system. As participants earn points or complete challenges, they advance to higher levels. Each level typically comes with increased difficulty or complexity, offering new challenges and opportunities for skill development. Challenges are tasks or activities specifically designed to test participants' skills, knowledge, or abilities. Thus, gamification has clear benefit as it establishes clear objective goals for students to strive towards and makes learning more interactive, immersive, and engaging. Several studies [21], [22], [23], [24], [25] applied gamification to their education process, and all reported the noticeable and significant improvement of students' performance and motivation to learn.

These two approaches share benefits of increasing students' engagement and inspiration. However, gamification approach adds a sense of accomplishment from completing challenges and a clear visualization to keep track of progression. On the other hands, Imagineering approach pushes students to use imagination and abstractive thinking to improve students thinking skill. Hence, combining these two approaches should give better coverage in different aspects for students.

2.2. Learning Experience Platform

A Learning Experience Platform (LXP) is a digital learning solution that provides a personalized and engaging learning experience for users [26], [27]. Unlike traditional learning management systems which focus primarily on course administration and content delivery, LXPs prioritize learner's experience by curating personalized content, fostering collaboration, and promoting continuous learning and skill development [28], [29], [30]. Ones of key features of LXP include personalization and suitability for skills development and assessments. In terms of personalization, LXPs use matching algorithms and user profile data to individualize learning experiences based on individual preferences, goals, and learning styles. Learners receive recommendations for relevant content, courses, and resources tailored to their interests and skill levels. Furthermore, LXPs are suitable for skill development and competency-based learning, providing tools for learners to track their progress, set learning goals, and assess their skills visually. Users can perform self-assessments by completing quizzes and challenges while they can receive feedback on their performance from an instructor to correct their mistakes and direct their improvement.

Moreover, LXPs can be integrated with supporting tools to assist users automatically using artificial intelligence (AI). An artificial intelligence learning platform was proposed to support instructional planning and content management to automatically recommend suitable learning materials to students [28]. In addition, a conceptual framework of an LXP was developed to strengthen students' AI competence by linking simulation technologies and AI [30]. These research studies showed that despite answers or solutions may be wrong or contains errors [31], the experience of interacting with AI helps students to realize the errors with critical thinking and systematically find how to move forward.

2.3. Problem-Solving Skills and Innovation Development

Problem-solving skills refer to the ability to identify, analyze, and solve problems effectively and efficiently. It involves using critical thinking, creativity, and systematic approaches to address challenges and overcome obstacles logically [7], [32]. Problem-solving skills are essential for both academic performance and real-life situations. Problem-solving skills are highly valued by employers across a wide range of disciplines and professions including business, engineering, healthcare, education, and technology.

As innovation development involves a process of computational thinking to design and finding logical and structural solution, there are several research studies linking problem-solving skills and learning of computer-software coding [33], [34], [35], [36], [37]. A previous study [36] proposed seven evaluation aspects for assessing problem-solving skills in development of a computational artifact via Scratch (platform for learning coding and creative expression in block-based programming language that allows users to create interactive stories and simple games).

The 7 evaluation aspects are as follows:

1) Flow Control is the ability to the overall plan a set of actions for events and develop instructions /Instructions related to algorithmic notions of flow control can help you to control the behavior of your characters,
2) Data representation is the ability to display the correct order of programming codes so that the program can run properly,
3) Abstraction is the ability of abstraction and decomposition of problems to break a problem into smaller parts that are easier to understand, program and debug,
4) User Interactivity is the ability to input information that would change the program, such as integrating audio or video into the programming codes in order to trigger certain actions,
5) Synchronization is instructions related to synchronization allowing characters to organize things in the order the coder intends,
6) Parallelism is the possibility that several things occur simultaneously, and
7) Logic and Logical Thinking is instructions related to logical thinking that involves the 'if-then-else' construction to control the condition of character/event actions.

3. Research Methodology

There are three phases of this study:

Phase I: Development of Imagineering Gamification Model via Learning Experience Platform:

1) Synthesizing information of Imagineering teaching approach using 9 related international research studies from academic publication database between 2010 and 2023. Information synthesizing tools include a content analysis form and content analysis.
2) Synthesizing information of gamification using 12 related international research studies from academic publication database between 2018 and 2023. Information synthesizing tools include a content analysis form and content analysis.

3) Developing an Imagineering Gamification model on learning experience platform for enhancing innovation problem solving abilities.

Phase II: Development of Learning Experience Platform for the developed Imagineering Gamification Model:

1) A development of the platform follows System Development Life Cycle [38] as follows:

a) Requirements Gathering and Analysis: This initial stage composes of problem recognition, feasibility study, and analyze users' needs based on competency-based curriculum.
b) Design: The platform is designed towards personalized learning experience to encourage an improvement of problem-solving skill and creative thinking. The design is to realize difference in students' pre-existing skill and goal of each individual, and the system thus provides appropriate level of learning content for best learning experience and outcome.
c) Implementation: The implementation stage involves the actual coding and development of the software system based on the design specifications. This stage focuses on turning the design into a functioning platform.
d) Verification: In this stage, the implemented platform undergoes rigorous testing to identify and fix defects, bugs, and errors. The chosen testing is to verify a personalized function and content selection of the platform.
e) System Maintenance: The maintenance stage involves ongoing support and updates new contents to the platform after it has been deployed. The support includes fixing bugs, updating new contents, and ensuring the platform remains accessible for students.

2) The developed Imagineering Gamification model on learning experience platform was evaluated by seven experts selected using a purposive sampling method, including one expert in each field of Imagineering approach, gamification approach, learning experience platform, educational technology, problem solving skills, and creative thinking. All experts had at least five years of experience in at least one of the aforementioned fields. The evaluation instrument was a questionnaire for assessing the appropriateness of a teaching model while evaluation analysis applies mean and standard deviation calculation.

Phase III: Comparison study on proficiency of students' problem-solving skills before and after using the developed Learning Experience Platform for Imagineering Gamification Model.

In this phase, an experiment is conducted to examine a change in students' proficiency of problem-solving skills from using the developed Learning Experience Platform for Imagineering Gamification Model. The experiment consists of 3 main phases within a duration of 8 weeks. The details of 3 phases are as follows:

1) Pre-experimental phase:

a) Orientation: This phase involves orientation to explain objectives of the experiment, introduction of the developed platform, and how to use the platform.
b) Pretest: This phase is conducted to determine student's pre-existing skill on problem-solving and creative thinking skill. The obtained test result is then accounted for personalizing the providing contents based on the obtained level.
c) Practice: Students are taught on how to utilize and practice using the provided supporting tools in the platform including automated analytics-driven personalized learning, and an intelligent learning experience supporting modules (intelligent visualizing, classmate collaborating, design module, intelligent conversation agent module, gamified project-based assessment module and intelligent personal assistant module).

2) Learning and training using the developed platform phase: Students attend a class using the platform on the topic innovative thinking using block-based programming. The class is once a week and lasts for 4 hours.

3) Evaluation phase:

a) Evaluation of students' problem-solving skill: There are 10 aspects to be assessed as follows:

1. Flow control
2. Data representations
3. Abstraction
4. Code decomposition
5. User interactivity
6. Synchronization
7. Parallelism
8. Programming logic
9. Extension
10. Iterative and recursive

Holistic rubric is used to rate the students' work as a 0 to 3 for need improvement, developing, sufficient, and above average, respectively. With 10 aspects, the total score is 30 points. The assessment is given in the gamified project-based assessment module, and the assessed score can be viewed for both instructor and student.

b) Interpretation of students' problem-solving skills: The students' scores are interpreted as follows:

25 – 30 score: having *highest* proficiency in problem-solving.
19 – 24 score: having *high* proficiency in problem-solving.
13 – 18 score: having *moderate* proficiency in problem-solving.
7 – 12 score: having *low* proficiency in problem-solving.
1 – 6 score: having *lowest* proficiency in problem-solving.

4. Research Findings

There are three parts in this section including 1) Information synthesizing and platform designing, 2) Usage assessment of the designed platform, and 3) Evaluation of improvement in learners' problem solving in innovation abilities.

4.1. Information Synthesizing and Platform Designing

There are four parts in this subsection, 1) Synthesizing Imagineering process, 2) Synthesizing gamification elements, 3) Designing the conceptual framework, and 4) Evaluation results of the design of learning approach.

4.1.1. Synthesizing Imagineering Process

From intensive reviews, the provided information on Imagineering in publications was synthesized and the results are shown in Table 1.

Table 1. Synthesizing results of Imagineering process

Imagineering Process	[39]	[40]	[41]	[42]	[9]	[20]	[10]	Synthesis Results
Inspire	✓							
Imagine	✓	✓	✓	✓	✓	✓	✓	✓
Designing	✓	✓	✓	✓	✓		✓	✓
Development	✓	✓	✓	✓	✓	✓	✓	✓
Presentation	✓	✓	✓	✓	✓	✓	✓	✓
Improvement	✓	✓	✓	✓	✓			✓
Evaluation	✓	✓	✓	✓	✓			✓
Reflect	✓							

In Table 1, common Imagineering processes in the literatures comprise 6 common processes as follows:

1) Imagine: This is a process to imagine of products from given questions or problems. It can be done by brainstorming, discussion, and analysis in a group.
2) Designing: This process is to conceptualize the idea or solution from previous process into visualized elements. This includes drawing blueprint, scriptwriting, flowchart and model design, etc.
3) Development: This process involves of turning design concepts into tangible objects. In the implementation, some procedures including required data/material preparation, coding or constructing, and testing are mandatory.
4) Presentation: Presentation is an essential process of Imagineering as students should effectively communicate their ideas and concepts to collaborators and other students. Students may use visualized presentations or storytelling techniques to convey elements of their work and receive feedbacks from instructor and other students.
5) Improvement: This process is to refine and enhance students' output based on feedbacks or self-reflection.
6) Summarization and reason of adjustment are required to keep track of the changes.
7) Evaluation: The process of evaluation is to assess the effectiveness and success of their outputs through given metrics and criteria.

4.1.2. Synthesizing Gamification Process

From intensive reviews, the provided information on gamification in literature was synthesized and the results are shown in Table 2.

Table 2. Synthesizing results of gamification process

Gamification Element	[24]	[43]	[13]	[11]	[22]	[44]	[21]	[25]	[14]	[45]	[23]	**Synthesis Results**
Points	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Badge	✓	✓	✓		✓	✓	✓			✓	✓	✓
Leaderboard	✓		✓	✓	✓	✓		✓	✓			✓
Level	✓		✓	✓	✓		✓	✓	✓	✓		✓
Reward				✓	✓	✓	✓			✓		✓
Feedback	✓		✓	✓	✓	✓	✓			✓		✓
Challenge				✓	✓	✓	✓	✓	✓			✓

Table 2 shows that common gamification elements comprise 7 elements: Point, Badge, Leaderboard, Level, Reward, Feedback, and Challenge.

4.1.3. Design of the Conceptual Framework

From the obtained synthesized information, the conceptual framework of the Imagineering Gamification model on a learning experience management platform was designed accordingly.

The conceptual framework is illustrated in Figure 1.

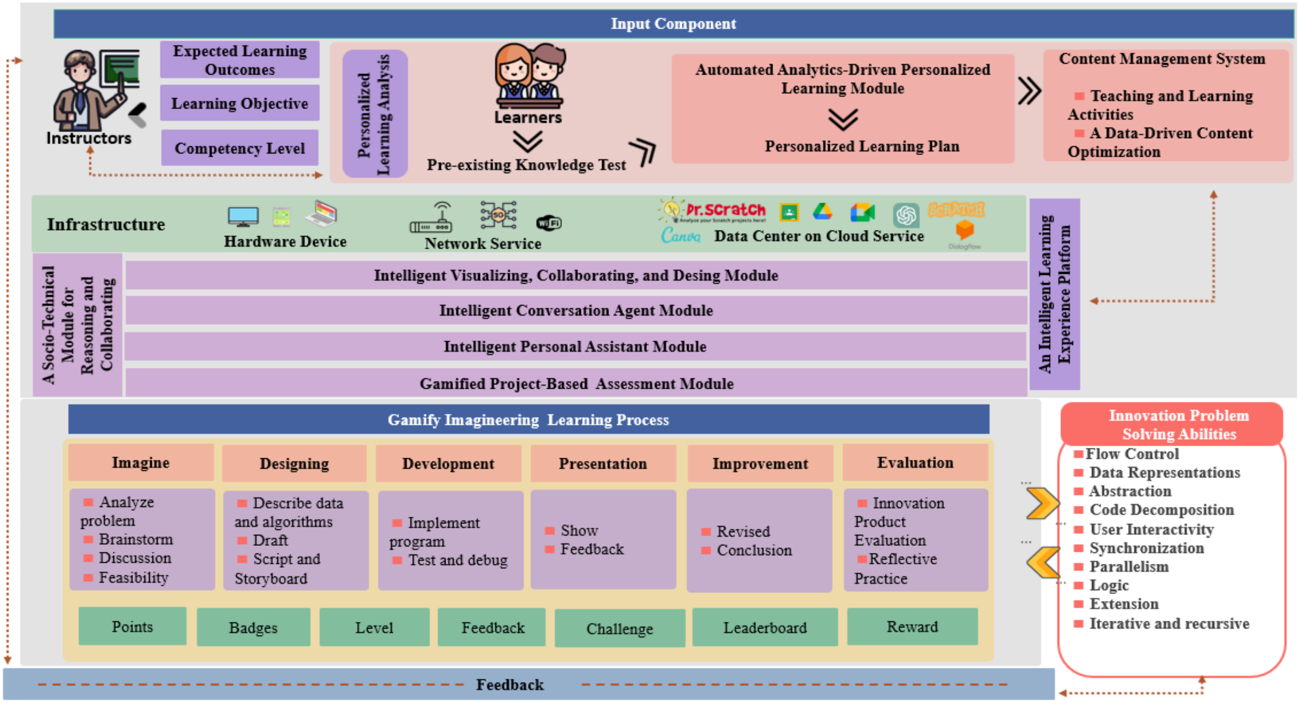

Figure 1. The conceptual framework of the Imagineering Gamification Model on an intelligent learning experience management platform

The framework consists of 3 main parts including input, learning, and evaluation and feedback. Details of each part are as follows.

1) Input Components:

Expected Learning Outcomes: Learners have a practical experience on problem solving, have good attitude and become familiar to computer and artificial intelligence system.

- Learning Objective: Learners improve their systematic problem-solving skill and become AI literacy.
- Competency Level: Leaners are assessed into 4 levels (0 - 3) for 10 aspects including:

1) Flow control
2) Data representations
3) Abstraction
4) Code decomposition
5) User interactivity
6) Synchronization
7) Parallelism
8) Logic
9) Extension
10) Iterative and recursive

The summary level of individual learner is used to determine a degree of gamifying elements such as level of challenge and point criteria.

- Personalized Learning Analysis: This analysis is to analyze an individual learner on competency level. The analysis includes:
  - Pre-existing Knowledge Test: Learners demonstrate knowledge of visual programming via the given tools such as Scratch, micro:bit, and KidBright. The base knowledge of the learners may vary from different chosen course and background. Thus, it is important to realize their existing knowledge and skill to properly and accordingly assign their target.
  - Automated Analytics-Driven Personalized Learning: Learners are assigned with different learning experience based on their assessed existing knowledge.

- Personalized Learning Plan: Responsible instructor designs teaching plan according to learning objective and learners' knowledge with the provided tools.
- Content Management System: This system is designed to manage the learning content and apply to the tools.
  - Teaching Activities: Instructors design learners' activities based on Imagineering gamification approach and list learning resources and guideline on learning tasks. Instructors are also tasked with methods for assessment of learning outcomes based on authentic assessment, immediate feedback, and adjusting learning activities.
  - Learning Activities: Learners are to work on assigned tasks and set a goal of the learning. Furthermore, learners should learn on their own understanding, process information from learning resources, practice, and self-assess their own performance.
- An Intelligent Learning Experience Platform
  - Infrastructure: Hardware Device, Network, and Data Center on Cloud Service.
  - A Socio-Technical Module for Reasoning and Collaborating:
    - Intelligent Personal Assistant Module: This module is a generative artificial intelligence system responsible for filtering inappropriate options, selecting proper coding library according to given objectives, and providing textual guidance and usage instruction of the platform.
    - Intelligent Visualizing, Collaborating, and Designing Module: Learners can interact with this module in creating visualizing plan and character or scene design.
    - Intelligent Conversation Agent Module: This module is a chatbot developed specifically to converse with learners for providing detail information, giving examples, and pointing out related learning materials and resources. It can also provide instruction based on 10 evaluation aspects.

2) Learning Components:

Learning components define learning process systematically. In this work, the concept of combination of Imagineering and gamification approach to assist on improving learners' problem solving and creative skill is applied.

- Imagine: This initial process is to inform learners of learning objectives, evaluation criteria, and expected learning goal. Instructor then provides a push and inspiration for learners to think off their own output of programing project. In this part, the processes consist of 1) Define the problem) 2) Brainstorm to find potential solutions 3) Discussion to select the best solution for the defined problems, and 4) Study feasibility of the solution. In these processes, the Socio-technical module for reasoning and collaborating is provided to assist learners in the task.
- Designing: This process includes drafting, describing algorithm and data, and designing script and storyboard. The drafting is to propose a preliminary version of learners' overview idea in a visualization form. Then, learners describe the proposed algorithm and used data by analyzing possible input, output, and required methods to process the input towards the output. Last, learners are to design script and storyboard according to the proposed algorithm.
- Development: In this process, 2 parts are involved including programing and debugging. Learners use the Socio-technical module for reasoning and collaborating to help in this process. In the debugging process, learners are to reflect on error they made as well as learn on how to correct the error.
- Presentation: This part is for learners to make a presentation and receive feedback from instructor and other students to improve their work.
- Improvement: Learners with the help of the Socio-technical module for reasoning and collaborating are asked to improve their work and summarize their learning as a report.
- Evaluation: This process is to evaluate the innovation output and performs a reflective practice. The evaluation is performed via gamified project-based assessment module, and learners are asked to discuss on what they learn with instructors and opinion towards the platform.

3) Evaluation and Feedback Components:

This section is to explain evaluation aspects used to assess the innovation product made by learners. The evaluation rating is in a range of 0 to 3, while 0 represents the lowest and 3 is the highest in each aspect. The aspects are given in Table 3.

Table 3. Evaluation aspects to assess learners' innovation product

Aspect	Description	Rating Criteria
Flow Control	To evaluate the order of a process execution or a set of actions in a logical manner to get the solution to the problem [36], [46].	0 if no flow control. 1 if flow is not logically correct. 2 if flow is partially correct. 3 if flow is logically correct.
Data Representations	To evaluate choice of data, analysis of data, and representation of data to help solve a problem [47].	0 if no data mentioned. 1 if data are mentioned, but not analyzed. 2 if data are analyzed but incorrect. 3 if data are correctly analyzed.
Abstraction	To evaluate a created model by extracting the fundamental characteristics of the solutions in generic terms without unnecessary component [33], [35], [36], [47].	0 if function code is not abstracted. 1 if function code is partially correct. 2 if function code is correctly functional as intended, but not reusable or not reused even if it could or there is an irrelevant part. 3 if function code is correctly functional and reusable without irrelevant part.
Code Decomposition	Evaluation of how learners break down the problems into smaller subproblems, so each function implements only a single task and to identify the specific functions without unnecessary programming code [35], [46], [47].	0 if code is not separated into function. 1 if code is partially separated into function. 2 if code is fully separated into function, but there is dead code (code not in used). 3 if code is fully separated into function without dead code.
User Interactivity	To evaluate the ability of the programing code that interacts to input to trigger certain actions [36].	0 if there is no code to interact with user. 1 if there is a code to interact with user but inconsistently. 2 if there are codes to interact appropriately with various user-generated events. 3 if the program has advanced capabilities in handling complex user-generated events and environment such as microphone, webcam, or sensor.
Synchronization	To evaluate the ability of the programing code that can connect to one another effectively for future action coordination or event timestamping [34], [36].	0 if there is no synchronization mechanisms in the program. 1 if there is a basic or incomplete use of wait or receive actions. 2 if there are appropriately uses of wait or receive actions for various synchronization scenarios with some conflicts. 3 if the program demonstrates a sophisticated use of complex synchronization requirements such as future action coordination or event timestamping.
Parallelism	Evaluation of the use of complex coding in parallel such as to get several sensing inputs from environment and use them in different function simultaneously [33], [36], [47].	0 if the code does not leverage parallel processing. 1 if the code contains basic attempts at parallelism with minimal impact. 2 if the code utilizes parallel processing to enhance performance and some performance improvement with parallelism. 3 if the code utilizes parallel processing to enhance performance and improve performance with parallelism without issue.
Logic	To evaluate of logical use within the programming code involving in the use of 'if-then-else", logical operation, and "and/or" structure. [33], [36].	0 if code does not contain logical expression. 1 if code contains only IF logical expression. 2 if code contains only IF and ELSE logical expression. 3 if code contains many IF and ELSE logical expressions together without error.
Extension	Evaluation of the design of the context that may be extended to further usage or improvement. This also involves the reusability such as the use of plug-in.	0 if there is no usable feature in the extension. 1 if the extension feature has significant errors. 2 if the extension feature produces mostly correct results with some inaccuracies. 3 if the extension feature is highly reliable and precise.
Iterative or recursive	To evaluate control structures using conditional statements and coding loops [33], [36], [47].	0 of there is no evidence of understanding how to implement iterative or recursive processes. 1 if the program includes simple iterations or recursions but lacks complexity or efficiency. 2 if the program demonstrates a solid understanding of iterative or recursive processes. Clarity and Readability 3 if the program demonstrates the control structure showcases mastery in utilizing conditional statements and loops.

4.1.4. Evaluation Results of the Design of Learning Approach

In this section, an evaluation was conducted to assess the appropriateness of the design of combining Imagineering and gamification for use in the learning experience management platform.

The evaluation results from experts are given in Table 4.

Table 4. Evaluation results from experts regarding the designed method

Evaluation list	***Mean***	***S.D.***
Input process		
1. Expected Learning Outcomes	4.86	0.35
2. Learning Objective	4.86	0.35
3. Competency Level	4.86	0.35
4. Personalized Learning Analysis	4.86	0.35
5. An Intelligent Learning Experience Platform	4.71	0.45
Total of Input Process	**4.83**	**0.38**
Learning Process		
1. Imagine	4.86	0.35
2. Designing	4.86	0.35
3. Development	4.86	0.35
4. Presentation	4.71	0.45
5. Improvement	4.71	0.45
6. Evaluation	4.86	0.35
Total of Learning Process	**4.81**	**0.39**
Output and Feedback Process		
1.Flow Control	4.86	0.35
2.Data Representations	4.71	0.45
3.Abstraction	4.43	0.73
4.Code Decomposition	4.71	0.45
5.User Interactivity	4.86	0.35
6.Synchronization	4.86	0.35
7.Parallelism	4.71	0.45
8.Logic	4.86	0.35
9.Extension	4.86	0.35
10. Iterative and recursive	4.86	0.35
Total of Output and Feedback Process	**4.77**	**0.45**
Total	**4.80**	**0.42**

4.2. An Investigation into the Appropriateness of the Imagineering Gamification Model on Learning Experience Management Platform

There are two parts in this subsection, including 1) Development of learning experience management platform for the Imagineering Gamification Model, and 2) Evaluation results regarding appropriateness of the platform.

4.2.1. Development of Learning Experience Management Platform for the Imagineering Gamification Model

The learning experience management platform was developed following the aforementioned design as shown in Figure 2.

The usage of the platform is different for users in a role of instructor and learner. For the users in a role of instructor, they are responsible of setting ‘Expected Learning Outcomes’, clarifying ‘Learning Objective’, defining ‘Competency Level’, and preparing learning materials and contents for the platform. The users in a role of learner starts their task by taking the pre-existing knowledge test to determine their current level which is used for personalizing their content by automated analytics-driven personalized learning module. The module generates personalized learning plan to work with content management system.

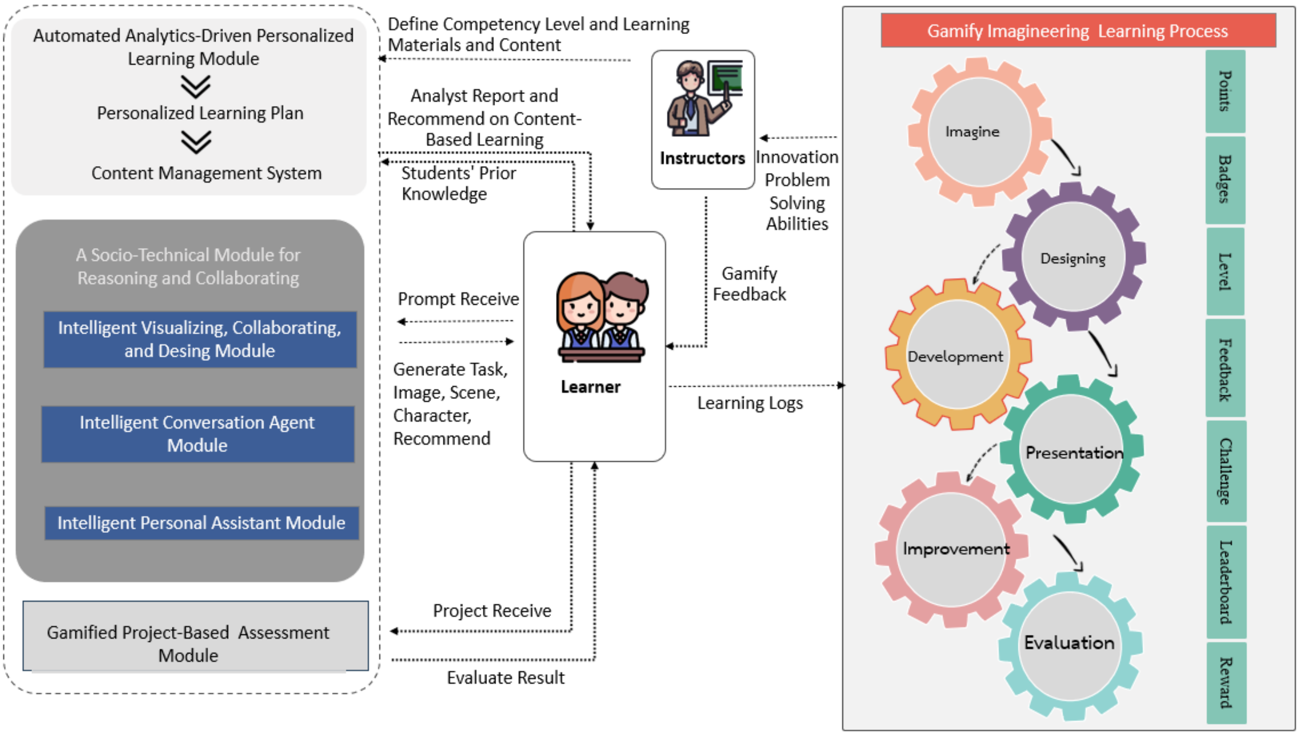

Figure 2. Learning experience management platform for the Imagineering Gamification Model

Then, the learner users follow the learning step previously given in Learning Component Section. For supporting the learning, the Intelligent Learning Experience Platform provides 4 supporting modules including Gamified Project-Based Assessment Module, Intelligent Personal Assistant Module, Intelligent Visualizing, Collaborating, and Design Module, and Intelligent Conversation Agent Module.

4.2.2. Evaluation Results Regarding Appropriateness of the Platform

In this section, an evaluation was conducted to assess the appropriateness of the learning experience management platform. The evaluation results from experts are given in Table 5.

Table 5. Evaluation results regarding appropriateness of the platform

Evaluation list	*Mean*	*S.D.*
An Intelligent Learning Experience Platform		
1. Intelligent Visualizing, Collaborating, and Design Module	4.86	0.35
2. Intelligent Personal Assistant Module	4.57	0.49
3. Intelligent Conversation Agent Module	4.86	0.35
4. Gamified Project-Based Assessment Module	4.86	0.35
Total of an Intelligent Learning Experience Platform	**4.79**	**0.41**

4.3. Evaluation of Improvement in Learners' Problem Solving in Innovation Abilities

Learners' innovation problem solving abilities were compared before and after using the platform to find if the learners significantly improve their skill or not. The comparison result of their improvement is given in Table 6.

Table 6. Paired sample T-Test

Statistic	N=30				
	Mean	SD	t	df	Sig. (2-tailed)
Initial Abilities	14.40	4.80	-29.38	29	.000
Final Abilities	21.80	5.95			

*** p < .01*

Results indicated that learners had an average score of 14.40 and 21.80 before and after using the platform in the experiment period, respectively. By applying T-test, the improvement of the score is found to be significant of .01 level of significance.

5. Results and Discussion

This paper presents a combination approach of Imagineering and gamification in a learning experience management platform to help learners improve problem solving skill in a class of software programing.

By combining the use of Imagineering to encourage thinking outside the box and exploring creative solutions to problems and gamification to provide intrinsic motivation for learners to achieve goals and progress through the content, the learners become motivated and can improve their skill effectively, unlike traditional learning method such as lecturing and self-reading. The combined approach is then applied in the developed learning experience management platform to provide personalization and assistance of recent technology such as generative AI and chatbot to live support the learners.

The conceptual framework of the combination as the Imagineering gamification model on learning experience management platform consists of 3 main parts including input components, learning components, and evaluation and feedback components. The input components from information synthesis are to declare expected learning outcomes, to set learning objective, to realize competency level, and to have a learning experience management platform. The synthesized components of learning part include 2 concepts as Imagineering and gamification. The former includes the process Imagine, Designing, Development, Presentation, Improvement, and Evaluation. For the latter, the chosen gamified components are point, badge, leaderboard, level, reward, feedback, and challenge. The evaluation result of the framework signifies that the combining approach show good potential and appropriate for learners. Experts evaluated the approach in terms of appropriateness in highest degree ($\bar{x} = 4.80$), ($S.D. = 0.42$) which supports the objective 1.

The development of the learning experience management platform for the Imagineering Gamification model in this work composes of 1) Gamified Project-Based Assessment Module, 2) Intelligent Personal Assistant Module, 3) Intelligent Visualizing, Collaborating, and Design Module, and 4) Intelligent Conversation Agent Module. The evaluation of the platform showed the result of high degree ($\bar{x} = 4.79$), ($S.D. = 0.41$) which supports the objective 2 of the research.

From the experiment of comparing problem-solving skill in developing an innovation before and after using the platform, Paired sample T-Test results indicated that the improvement of the learners' problem-solving skill is significant higher from the level of significance at 0.01. This result conforms the objective 3 of the research.

The use of concept Imagineering shows positive results in improving thinking outside the box and exploring creative solutions from inspiring curiosity and encouraging exploration. In this study, Imagineering approach tasks learners with brainstorming and conceptualization of problem and solution.

Learners thus explore their thought with their classmates in creative discussion and motivate one another to think more or learn of other opinion and their thinking process. Thus, Imagineering approach gives a positive and fresh aspect to learning environment, as also mentioned in the research from. Furthermore, the Imagineering approach allows learners to connect their conceptual problem and solution via immersive storytelling; hence, it leads their thinking process to be more systematic and found to significantly improve their systematic thinking skill [40].

For gamification approach, this work incorporates the concept of competency level and challenge in their learning experience. Competency levels in gamified learning systems allow learners to track their progress and see their advancement over time [12]. Furthermore, it gives learners a sense of achievement once they pass a level which enhances learners' motivation and self-esteem leading them to continue learning and striving for excellence. On the other hand, challenges in learning tasks stimulate students' interest and engagement. When learners face challenges, they are more likely to invest effort and focus on overcoming them as to positively increase learners' emotional engagement to learning [24].

6. Conclusion

This paper introduces a novel approach combining Imagineering and gamification within a learning experience management platform to enhance an innovation problem solving abilities in undergraduate students. The results suggest that learners' innovation problem solving abilities improved after using the platform, indicating that the proposed approach helped achieve the study objectives.

Imagineering fosters problem solving and promotes creativity and systematic thinking. Gamification facilitates learner progression and strengthens motivation, progress tracking, and engagement throughout the learning process. The platform also enables personalized learning support by integrating advanced technologies such as generative AI and a chatbot, which can provide guidance and assistance during learning activities and make skill development more engaging and effective.

Although simple random sampling was applied from the stated population, the implementation involved a relatively small sample of undergraduate students from computer-related departments and was conducted in a specific instructional context. Therefore, the generalizability of the findings may be limited, and the results should be interpreted with caution when extending the conclusions to other disciplines or different learning settings.

Future research should examine the approach beyond computer-related student groups and block-based programming activities. Replications across disciplines, learning environments, and task types would provide stronger evidence of broader applicability and help clarify how context influences innovation problem-solving outcomes.

Acknowledgements

The authors acknowledge the publication fee support provided by the Research and Development Institute, Phetchabun Rajabhat University.

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