

Developing a Conceptual Framework for Adaptive Gamified Learning based on Personalized Learning in Polytechnic Programming Courses

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Abstract

This study proposes the development of a conceptual framework for adaptive gamified learning, integrated with personalized learning principles, aiming to enhance student achievement in programming courses at Malaysian polytechnics. Each student possesses unique learning styles and cognitive abilities, necessitating adaptive educational approaches. Gamification serves as a catalyst for expediting learning through enhanced engagement and motivation, while personalized learning tailors educational paths to individual needs, interests, and aspirations. The research addresses challenges faced by educators in integrating gamification and personalized learning into technical education, particularly concerning the preparation of teaching materials for online environments and fostering lecturer motivation. The proposed framework aims to guide the design of instructional aids that simplify preparation for lecturers, potentially reducing preparation time and allowing more time for student engagement. This paper outlines the research objectives, problem statement, scope, significance, and the Systematic Literature Review (SLR) based methodology for developing this conceptual framework. The findings are expected to contribute to strategies for improving student mastery in programming and guide policy planners in leveraging ICT for effective teaching and learning.

Keywords: Adaptive gamification; Personalized learning; Conceptual framework; Programming education; Polytechnic Malaysia; Instructional design

1. Introduction

Every student approach learning and conceptualizes information uniquely. Modern technological advancements offer educators a crucial advantage in tailoring educational materials to meet these diverse student requirements. The true value lies not primarily in the specific technology deployed, but rather in empowering students to leverage their individual intellectual strengths within the learning environment, thereby fostering a more proactive and receptive learning attitude. This study aims to empower polytechnic lecturers by providing them with instructional aids built upon the foundations of gamification and personalized learning. This approach seeks to eliminate the necessity for lecturers to acquire extensive programming expertise and to substantially cut down the time spent on preparing teaching resources. As a beneficial consequence, lecturers would gain more time to captivate students' interest, encouraging them to actively engage with and utilize the provided learning materials. At its core, personalized learning emphasizes delivering high-quality educational experiences that are truly fit for purpose. The key tenets of personalized learning are effectively encapsulated by the acronym SCARCETIME. Essentially, personalized learning functions as a system designed to respond directly to individual students, crafting tailored learning journeys that align with their specific needs, interests, and future aspirations (Rattadilok et al., 2019).

Gamification, at its essence, is understood as a powerful driver to accelerate learning by enhancing both engagement and motivation (Ong et al., 2013). Research suggests that integrating gamification can be highly enjoyable and academically beneficial for most students (Hitchens & Tulloch, 2018). Teachers play a pivotal role in embracing gamification as a pedagogical tool to fully unlock its potential benefits. Furthermore, a wealth of evidence from literature reviews consistently supports gamification's positive influence in promoting effective learning outcomes (Saggah et al., 2020). In recent years, educational development has seen a surge of interest in gamification, largely driven by its potential to enrich students' overall learning experiences, particularly within classroom settings. Educators are continuously exploring innovative methods to deepen student engagement during lessons, with the goal that this heightened involvement will lead to greater knowledge acquisition and, subsequently, improved performance in assessments.

2. Background of Study

In the contemporary educational landscape, particularly within polytechnics, incorporating online learning into instructional design has become an essential practice. Effective technological integration necessitates a careful blend of diverse materials, strategic approaches, and well-established methodologies. Educators bear the responsibility of delivering impactful teaching and fostering high-quality classroom engagements for their students. Such efforts directly influence learning preferences and how students perceive the tools instructors employ. This current investigation involves both lecturers and students from polytechnic institutions across Malaysia.

Malaysian polytechnics generally function as publicly funded higher education institutions. They provide technical and vocational programs to upper-secondary school graduates, leading to either diploma or certificate qualifications. Since January 1, 2005, these polytechnics have extended their technical and vocational courses to Sijil Pelajaran Malaysia (SPM) school leavers. Polytechnic education in Malaysia originated in 1969 under the Colombo Plan. Continuously striving to meet the escalating demand for a skilled workforce, the Ministry of Higher Education (MOHE) consistently enhances the nation's polytechnic system. These institutions are pivotal in supplying skilled semi-professionals in fields such as engineering, commerce, and hospitality at Diploma and Certificate levels, thereby fulfilling the needs of both public and private sectors. Annually, polytechnics conduct two intakes for SPM and Sijil Pelajaran Malaysia Vokasional (SPMV) students. Each intake typically offers approximately 21,400 places to eligible candidates. The course offerings are extensive, including 24 Certificate programs, 45 Diploma programs across various disciplines, and 12 bridging courses. Additionally, they provide five specialized skills programs catering to students with needs. As of July 2007, a significant number, around 83,000 full-time students, were pursuing studies in polytechnics nationwide. The appeal of polytechnic education and training has steadily grown over time. For instance, during the 2012/2013 admission session, a large pool of 253,012 school leavers applied to polytechnics, though only 15,855 were successfully enrolled (Nordin, 2013). On September 16, 2009, a significant organizational shift occurred: the Department of Polytechnic and Community College underwent restructuring, leading to the formation of two distinct entities: the Department of Polytechnic (JPP) and the Department of Community Colleges (JPKK). This division aimed to revitalize their branding and propel both institutions towards increased commercialization. The goal was to cultivate innovative human capital possessing high employability value.

Currently, JPP oversees the operations of 30 polytechnics, which deliver a wide array of study and training programs in engineering, trade, and services. This network also includes three premier polytechnics that have commenced offering bachelor's degree programs. During the Polytechnic Transformation launch on February 25, 2010, the Deputy Prime Minister announced that three polytechnics—Politeknik Ungku Omar (PUO), Politeknik Sultan Salahuddin Abdul Aziz Shah (PSA), and Sultan Ibrahim Polytechnic (previously known as Politeknik Johor Bahru, PJB)—were elevated to Premier Polytechnic status. This upgrade granted them the autonomy to determine policy implementation complementing their enhanced standing. Specifically, Premier Polytechnics received permission to modify up to 30% of their learning modules, focusing particularly on their respective niche subject areas. These Premier Polytechnics are expected to serve as benchmarks for other polytechnics, aiming to advance the institution by providing higher education levels for graduates from the Certificate of Education (SPM), the Malaysian Higher School Certificate (STPM), and other Matriculation College students. Projections indicate that Premier Polytechnics are set to produce graduates with diploma, advanced diploma, and degree qualifications by 2015. Additionally, three metro polytechnics are now operational: Politeknik Metro Kuala Lumpur (PMKL), Metro Politeknik Kuantan (PMKu), and Metro Politeknik Johor Bahru (PMJB). The 'Boutique Polytechnic' concept underpins the Polytechnic Metro model, offering education and training designed to cater to the specific needs of local and regional service-oriented industries. These Metro Polytechnics extend training and educational opportunities not only to school leavers but also to working professionals seeking to enhance their knowledge and skills. Meeting the nation's demand for skilled workers in the service industry is paramount, a need partially addressed through courses provided via the Distance Education Programme (DE). Fundamentally, innovation in teaching and learning remains a core prerequisite for achieving educational excellence. By embracing current trends in online learning and effectively utilizing cutting-edge technology, institutions can foster greater understanding and critical thinking abilities among students (Nordin, 2013).

3. Literature Review

This section serves to synthesize existing scholarly work relevant to gamification, personalized learning, and their integrated adaptive application, with a particular focus on programming education. The objective of this review is to lay down the theoretical groundwork and to pinpoint crucial insights essential for developing the proposed conceptual framework.

3.1 Gamification in Education Gamification

Gamification, defined as the integration of game design elements and principles into non-game contexts (Deterding et al., 2011), has seen a substantial increase in adoption within educational settings. Its fundamental purpose is to amplify engagement, motivation, and ultimately, learning outcomes. Research consistently indicates that gamification can significantly nurture students' motivational, cognitive, social, and emotional development (Saxena & Mishra, 2021). Furthermore, evidence strongly suggests that gamified online discussion platforms positively influence user engagement (Alsubhi et al., 2021) and have the potential to boost student performance, participation, and enjoyment across various courses (El-Shorbagy et al., 2020). The core concept driving gamification is to translate the inherent motivating power of video games into non-gaming environments.

However, merely transferring game elements is frequently insufficient; a thoughtfully designed gamified course demands meticulous planning to sustain student engagement throughout an entire semester (Nabizadeh et al., 2021). To further elevate motivation and enrich students' learning experiences in higher education, the utilization of engaging digital participation platforms is highly recommended (Campillo-Ferrer et al., 2020).

3.2 Personalized Learning

Personalized learning represents a pedagogical strategy that customizes education to precisely align with the distinct needs, interests, and aspirations of each individual student (Rattadilok et al., 2019). This approach fundamentally differs from conventional, uniform models by prioritizing the delivery of high-quality, purpose-fit learning experiences. The core tenets of personalized learning are effectively summarized by the SCARCETIME acronym (Ward, 2020), which underscores the importance of adaptability, individualized pacing, and relevant content. Digital learning environments inherently provide greater flexibility and expanded opportunities for personalized, student-centre, and lifelong learning (Shahrill et al., 2021). Furthermore, successful personalized online learning has been demonstrated to potentially foster deeper learning outcomes within higher education contexts (Sáiz-Manzanares et al., 2019).

3.3 Adaptive Gamification and Personalized Learning Integration

The synergistic relationship between gamification and personalized learning is an area of growing scholarly interest, especially concerning the creation of more impactful and captivating learning experiences. Literature highlights that a key strategy to enhance student performance, engagement, and enjoyment through gamification involves customizing the student's experience by identifying their unique personality traits, player types, or preferred learning styles (El-Shorbagy et al., 2020). Researchers are actively pursuing the development of personalized adaptive gamified applications, recognizing the significant potential of machine learning models to forecast individual performance and dynamically adjust game features and task difficulty as users interact (Lopez & Tucker, 2020).

Various adaptive gamification frameworks have been proposed to systematically design such integrated educational systems. Rozi et al. (2019) comprehensively reviewed the field, identifying five distinct types of adaptive gamification frameworks, typically composed of an adaptive gamification engine, an adaptive component, and a gamification display. Illustrative examples include the framework proposed by Hassan et al. (2019), which advocates for adaptive gamification experiences tailored to learning dimensions, and the Cadish and Ravid Framework (2014), which integrates gamification analytics to monitor user engagement. Similarly, Akour & Das (2020) put forward the concept of a smart total learning environment as a conceptual framework for future teaching-learning systems. Notably, Lavoué et al. (2019) were pioneers in proposing and investigating gamification adaptation within authentic, real-life learning environments. Their findings suggested that while adapting gaming features can increase participation primarily among the most engaged users, additional mechanisms might be necessary to ensure initial user retention and to mitigate disengagement.

3.4 Challenges in Implementation

Despite the acknowledged benefits, several obstacles persist, impeding the effective implementation of both gamification and personalized learning, particularly within specialized technical education environments such as polytechnics. These challenges encompass a general lack of awareness among educators regarding the diverse online platforms available for gamification, coupled with uncertainty about students' receptiveness to participate in gamified lessons (Ab Rahman et al., 2019). Furthermore, significant time constraints placed on lecturers for designing gamified content represent a considerable barrier, often described as a "demanding task" (Tolentino, 2019). Many educators also display a diminished motivation to fully utilize online tools, a reluctance often attributed to insufficient training, inadequate technical support, and a preference for traditional teaching methodologies (Embi, 2011). These identified challenges collectively underscore the critical need for a thoughtfully structured conceptual framework capable of guiding practical development efforts and effectively surmounting existing impediments.

4. Objectives of Study

This study aims to:

- Identify and synthesize the key components and elements of adaptive gamification and personalized learning relevant for programming courses.
- Propose a comprehensive conceptual framework that integrates adaptive gamification with personalized learning principles for polytechnic programming education.

5. Problem Statement

A significant portion of students reported feeling inadequately supported by both their university and teaching staff during periods of lockdown (Khan, M.A., 2021). Furthermore, educators frequently encounter various obstacles when attempting to implement gamification within the classroom and apply personalized learning theories to their teaching methodologies. Among the prominent challenges identified are a limited awareness among educators regarding available online platforms suitable for integrating gamification into lessons, alongside persistent questions about students' willingness to engage in gamified activities to boost their participation (Ab Rahman et al., 2019).

5.1 Teaching Strategy of Personalised Learning:

A core concern revolves around the personalized learning teaching approach, particularly in technical education settings. Online learning presents expanded possibilities for delivering programs in a more adaptable, student-centered, and lifelong learning format, offering students the convenience of initiating or pausing their studies as needed (Shahrill et al., 2021). This flexibility has been substantiated through numerous studies conducted across various contexts. More recently, technologies such as Virtual Reality (VR) and gamification are attracting considerable interest within market research, specifically pertaining to educational services. Leveraging VR and gamification allows for the construction of diverse teaching scenarios and pedagogical strategies, enabling researchers to observe and comprehend student reactions, motivation, and engagement within these varied learning experiences (Loureiro et al., 2021).

5.2 Preparation of Teaching Materials in Online Learning:

The second identified challenge pertains to the development of teaching materials for online learning environments. Offering a diverse range of instructional materials stands as a crucial factor in ensuring that classroom activities are both engaging and successful in maintaining student attention. All educators are expected to possess stronger ICT proficiencies than their students. Moreover, they must utilize all available digital platforms and communication channels not only for student interaction but also as integral tools to support the teaching and learning process. Lecturers should consistently be prepared to adapt their teaching and learning environments, embracing innovation to ensure classroom effectiveness. Beyond this, educators require a specific body of knowledge, expertise, and a variety of tools to conceptualize and produce interactive teaching materials. However, not all educators are familiar with the full spectrum of online learning tools, particularly Web 2.0 applications. Notably, comparatively few studies have focused on developing learning tools as opposed to teaching tools.

The methods used for instruction must also be carefully considered to create truly effective teaching resources. Additionally, the lecturer's influence in the classroom is paramount in shaping student achievement. Consequently, every necessary effort should be invested to ensure a positive impact on students. Therefore, educational institutions must commit to providing continuous professional development for lecturers, empowering them to refine their teaching skills and generate high-quality, impactful instructional aids. Lopez & Tucker (2020) note that while advancements are being made in personalized adaptive gamified applications, current methodologies often fall short in predicting an individual's performance before they complete a gamified task. Such predictive information could be invaluable for tailoring game features and adjusting task difficulty within gamified applications.

Furthermore, existing methods frequently lack the capability to dynamically capture individual student data as they interact with a gamified application. The significant time commitment required for designing a game is a well-documented challenge, with the design of gamified courses often described as a "demanding task" (Tolentino, 2019). Hence, the provision of intuitive templates presents a viable solution within this research, aiming to avoid overburdening teachers' schedules with mandatory training sessions they might struggle to attend, which could otherwise diminish their willingness to explore gamification tools in their teaching (Saggah et al., 2020). Workplace time constraints further compound environmental limitations, as evidenced by a study at Politeknik Mukah Sarawak, where the author highlighted an unsupportive learning environment for preparing materials (Jamia'an, 2010). The process of modifying and designing course content to implement effective teaching methods demands substantial time, effort, and dedication from lecturers.

5.3 Lack of Motivation in Teaching and Learning using Online Tools:

A third significant challenge relates to the diminished motivation among lecturers in Malaysian institutions concerning their engagement with online teaching and learning tools. Prior research, including work by Embi (2011), has consistently pointed to numerous issues and obstacles associated with online teaching and learning programs offered by various institutions.

Specifically, Embi (2011) reported that a large cohort of 1,635 Malaysian Higher Education Institutions (HEIs) lecturers cited several key reasons for not utilizing online learning in their classrooms. These included insufficient training, limited time, a preference for traditional teaching methods, a lack of technical support, inadequate facilities, an increased burden added to their existing teaching load, among other factors. A subsequent scenario study by Embi et al. (2012), involving 1022 lecturers from 58 Malaysian Institutions of Higher Learning (IHLs) – encompassing public and private IHLs, polytechnics, and community colleges – corroborated these findings. Their report indicated that more than half of the respondents identified insufficient time to prepare interactive lessons as the primary problem, followed closely by poor infrastructure, lack of training, and inadequate technical support.

Currently, Malaysia faces a deficit of high-quality online learning content. This situation may stem from financial constraints and a shortage of expertise in developing digital educational materials. Consequently, much of the existing online learning content exhibits low interactivity, leading to only a moderate impact on learners. Nevertheless, lecturers' intrinsic motivation to adapt their teaching styles and methods remains crucial. It is not always straightforward to discern what truly motivates lecturers to integrate online learning into their classrooms. Each lecturer must cultivate a strong personal drive to evolve their teaching and learning approach, ensuring that classroom activities become more stimulating and, in turn, encourage active participation and a competitive spirit among students. Loureiro et al. (2021) affirm that gamification enables the construction of diverse teaching scenarios and pedagogical strategies, facilitating the collection and understanding of students' reactions, motivation, and engagement within these experiences. Practical considerations for designing a gamified course include implementing continuous evaluation mechanisms throughout a semester to sustain student engagement and distribute the workload effectively (Nabizadeh et al., 2021).

Findings from a systematic review by Loureiro et al. (2021) demonstrate that gamification exerts a positive influence on engagement, particularly in the short term. The fundamental principle of gamification involves transferring the inherent motivational appeal of video games to non-gaming environments. However, a mere transfer of game elements is generally deemed insufficient to constitute true gamification (Garcia-Iruela & Hijiñ-Neira, 2020). Campillo-Ferrer et al. (2020) advocate for elevating gamification to a new level by utilizing attractive digital participation platforms to further ignite motivation and enrich students' learning experiences in higher education settings.

Table 1: Summary of Challenges in Implementing Adaptive Gamified Learning

Category	Identified Challenge	Supporting Citation
Pedagogical	Lack of awareness of gamified platforms	Ab Rahman et al. (2019)
Technical	Time-consuming material preparation	Tolentino (2019)
Motivational	Low lecturer motivation for e-learning	Embi (2011); Embi et al. (2012)
Infrastructure	Poor technical support and facilities	Jamia'an (2010)

6. Scope of Study

This investigation is specifically directed towards lecturers who already possess foundational understanding of online learning methodologies. As a result, the individuals participating in this research will comprise both lecturers and diploma-level students from Malaysian polytechnic institutions, particularly those within the Information Technology discipline. Our aim is to develop a conceptual framework for an online adaptive gamification system, intended as an instructional tool. This framework seeks to address existing pedagogical challenges, foster the implementation of effective teaching strategies within polytechnics, and boost lecturers' motivation to incorporate online learning in their classrooms. The educational content under consideration for this framework will draw from difficult subjects within the Information Technology Department, with a primary emphasis on programming courses. Consequently, the key participants for validating this framework will be Polytechnic lecturers and Diploma students specializing in this area.

7. Significance of the Study

The outcomes of this research are poised to offer substantial theoretical and practical contributions. This study holds considerable importance for all lecturers and students across polytechnic institutions. The insights and recommendations generated are anticipated to furnish effective strategies aimed at assisting students in mastering programming subjects and, more broadly, at empowering polytechnic instructors throughout Malaysia to enhance students' proficiency in programming. Moreover, the discoveries from this study can serve as valuable input for policy planners, enabling them to revise existing ICT policies and surmount obstacles that currently impede the seamless integration of ICT into teaching and learning practices. Additionally, this research will assist educators in specifically recognizing the challenges they encounter during the implementation and integration of ICT in their teaching, thereby equipping them to become more effective instructors. Ultimately, the findings from this study also have the potential to foster greater creativity among students in grasping challenging subjects. Complex topics can be made more accessible when instructors employ diverse teaching methods and engaging activities that genuinely motivate students to learn.

8. Methodological Approach for Conceptual Framework Development

Methodology defines all steps involved and the guiding principles for their execution. This study primarily centers on the conceptual formulation of an adaptive gamified learning framework. Consequently, the chosen methodological approach will prioritize a thorough synthesis of existing literature and detailed conceptualization, rather than immediate empirical experimentation. Students enrolled in programming subjects at polytechnic institutions serve as the intended context for this framework's future practical application.

To systematically build the proposed conceptual framework, this research will employ a Systematic Literature Review (SLR) approach, complemented by a Conceptual Synthesis. This methodology is selected for its rigorous capacity to identify, assess, and integrate all pertinent research concerning gamification, personalized learning, and adaptive learning within educational environments, especially programming contexts. The conceptual framework's development will unfold through distinct stages, as visually represented in Figure 1.

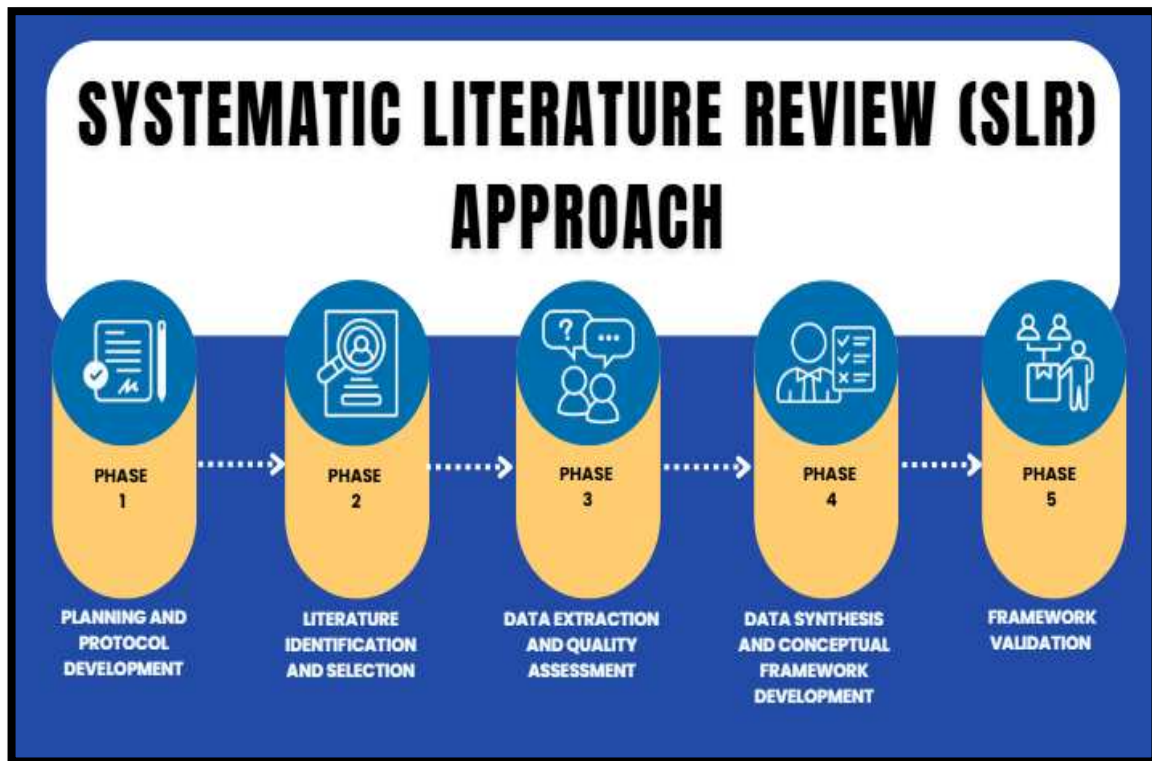


Figure 1: Systematic Literature Review (SLR) approach

8.1 Phase 1: Planning and Protocol Development

- This initial stage involves defining the research questions to guide the literature search and identifying relevant keywords and search terms (e.g., "adaptive gamification," "personalized learning," "programming education," "conceptual framework," "theoretical model").
- To ensure the relevance and quality of the selected studies, specific inclusion and exclusion criteria will be precisely established. Primary sources will include peer-reviewed journal articles, conference papers, and dissertations sourced from reputable academic databases.
- A comprehensive search strategy will be designed for databases such as Scopus, Web of Science, IEEE Xplore, ACM Digital Library, and Google Scholar to ensure broad coverage of the literature.

8.2 Phase 2: Literature Identification and Selection

- This stage involves the systematic execution of the pre-defined search strategy across the chosen databases.
- Identified studies will undergo a rigorous screening process, first by title and abstract, then by full-text review, against the predefined inclusion and exclusion criteria.
- A detailed record of the entire selection process, encompassing the number of studies initially identified, those screened, and ultimately, those included, will be meticulously maintained.

8.3 Phase 3: Data Extraction and Quality Assessment

- a. Relevant data will be systematically extracted from the selected studies. This data will include, but is not limited to:
 - i. Definitions and components of gamification and personalized learning.
 - ii. Existing adaptive gamification frameworks or models.
 - iii. Empirical findings on the impact of gamification and personalized learning on student engagement, motivation, and achievement, particularly in programming contexts.
 - iv. Identified challenges and best practices in implementing these approaches.
 - v. The underlying theoretical viewpoints or guiding principles.
- b. A thorough quality assessment will be conducted for each included study to ascertain its methodological rigor and its direct relevance to the development of the conceptual framework.

8.4 Phase 4: Data Synthesis and Conceptual Framework Development

- a. The extracted data will undergo analysis using a thematic synthesis approach. This process involves identifying recurring themes, patterns, and interrelationships across the various studies, which will then be systematically categorized.
- b. This comprehensive synthesis will directly inform the construction of the proposed conceptual framework. The framework will distinctly articulate the essential components of adaptive gamified learning, grounded in personalized learning principles, while illustrating their interconnectedness and positing how they are expected to influence student outcomes in programming courses.
- c. Furthermore, this framework will conceptually address the core research questions. It will outline appropriate adaptive gamification elements, detail their integration, and propose mechanisms for their personalized application within the learning environment.

8.5 Phase 5: Framework Validation

- a. The newly developed conceptual framework will then undergo a rigorous validation process through expert review. Esteemed experts in various fields, including educational technology, gamification, personalized learning, and programming education (e.g., experienced polytechnic lecturers, curriculum developers, and seasoned researchers), will be invited to provide critical evaluation of the framework.
- b. This validation exercise will meticulously assess the framework's clarity, its comprehensiveness, internal consistency, practical relevance, and overall applicability within the specific context of Malaysian polytechnics.
- c. Feedback from these experts will be systematically gathered (e.g., through structured interviews or detailed questionnaires) and subsequently utilized to refine and enhance the conceptual framework. This iterative feedback loop is crucial for ensuring the framework's robustness and theoretical soundness.

This methodological approach guarantees a stringent and systematic process for creating a well-supported conceptual framework founded on existing knowledge, thereby establishing a solid theoretical basis for subsequent empirical studies.

This methodological approach ensures a rigorous and systematic process for developing a well-substantiated conceptual framework based on existing knowledge, providing a strong theoretical foundation for future empirical studies.

9. Theoretical Framework

Students' participation and motivation are of great importance in their learning process. The decrease in attendance and difficulties in stimulating students' activity makes it necessary to find new methodologies that can solve these problems. The use of game mechanics in non-ludic environments (Gamification) has begun to be of great interest in research, since it could increase the motivation and therefore the activity of the students (Garcia-Iruela et al., 2020).

Reiners and Wood (2015) assert that to develop an effective gamification framework, four essential components are required to facilitate the assessment of each phase of the gamification process and to offer an integrative model. These components include: (1) Play Assessment Diagnostic, (2) a Gamification Scorecard, (3) Pre/Post Knowledge Assessment, and (4) Gamification Performance Assessment Review. It is widely observed that gamification initiatives guided by a clear design framework tend to yield more successful outcomes. Consequently, various researchers have put forward designs for adaptive gamification frameworks. A review of the literature identified five distinct types of adaptive gamification frameworks: these include the Framework of Hassan et al. (Hassan et al., 2019), the Cadish and Ravid Framework (2014), ALEF (Adaptive Learning Framework) (Filipcik & Bielikova, 2014), the Design Framework of the Proposed Social Learning Platform (Kim et al., 2015), and the Framework of Böckle et al. (M.Bockle et al., 2018). Generally, the proposed framework consists of three elements including adaptive gamification engine, adaptive component, and gamification display. Some researchers added other elements. Framework of Hassan et al. proposed a framework with adaptive gamification experience (activities and elements) based on the dimensions of learning (Hassan et al., 2019).

Cadish and Ravid Framework add gamification analytic for monitoring engagement or playfulness (R. Filipcik & M. Bielikova, 2014). Akour & Das (2020) proposed work of extensive study on an assortment of E-learning systems and the planned framework is the conceptual framework that is utterly smart, and it will endow with the total learning environment to the learners. Lavoué et al. (2019) study is the first to propose implementation of gamification adaptation in a learning environment in ecological, real-life conditions. Based on Lavoué et al. (2019) observations regarding learner participation, it appears that adapting gaming features can primarily boost involvement among the most active users. This suggests a need for identifying alternative mechanisms to ensure broader user retention, particularly at the initial stages of engagement. Secondly, it became apparent that learners might not always consciously recognize which specific gaming features most effectively motivate their interaction with the learning environment. Pertaining to the challenge of amotivation, their findings indicate that adapting gaming features can mitigate this risk, successfully keeping learners engaged in the educational activity even when their inherent intrinsic motivation may be lower.

9.1. Applying Gamification in Education

The concept of gamification is simple and effectively gamifying a concept by following a five-step process (Mertala, 2019) as shown in Figure 2 below:



Figure 2: Five-step Gamification Process

10. Results

This section presents the key findings derived from the systematic literature review (Phases 1-3 of the Methodology), which serve as the foundational evidence for the development of the conceptual framework.

10.1 Identified Core Components of Adaptive Gamification

The review revealed that effective adaptive gamification relies on several interconnected components frequently highlighted in literature:

- a. **Dynamic Rule-Based Systems:**
Studies emphasize the need for flexible game mechanics (e.g., points, badges, leaderboards) that dynamically adjust based on user progress, performance, and predefined conditions (Codish & Ravid, 2014; Hassan et al., 2019). This contrasts with static gamification, which often fails to maintain long-term engagement.
- b. **User Profiling Mechanisms:**
A crucial component identified is the ability to profile learners based on their individual characteristics such as learning styles, personality traits, player types (e.g., achievers, explorers, socializers), and prior knowledge (El-Shorbagy et al., 2020; Lopez & Tucker, 2020). This data informs the adaptation logic.
- c. **Personalized Feedback and Rewards:**
Effective adaptive systems provide immediate, tailored feedback and rewards that are meaningful to the individual learner, fostering motivation and confidence (Filipcik & Bielikova, 2014).

- d. **Adaptive Content and Task Difficulty:**
The literature supports the adjustment of learning content, exercises, and task difficulty in real-time to match the learner's current proficiency and pace, preventing frustration or boredom (Sáiz-Manzanares et al., 2019).
- e. **Social Interaction Elements:**
Even in online settings, gamification elements that facilitate social interaction (e.g., teamwork, collaborative challenges) are vital, addressing the inherent human need for social connection (Kim et al., 2015).

Table 2: Core Components of Adaptive Gamification

Component	Description	Source
Dynamic Rule-Based Systems	Adapts game mechanics based on learner progress	Codish & Ravid (2014)
User Profiling	Learner classification by traits, styles, knowledge	Lopez & Tucker (2020)
Personalized Feedback	Instant tailored feedback to learners	Filipcik & Bielikova (2014)
Adaptive Content	Content difficulty adjusts in real-time	Sáiz-Manzanares et al. (2019)
Social Elements	Promotes teamwork and interaction	Kim et al. (2015)

10.2 Principles of Personalized Learning in Practice

The systematic review reinforced the principles of personalized learning as foundational to adaptive gamification. Key aspects synthesized include:

- a. **Student Autonomy and Agency:**
Personalized learning empowers students with informed choice and control over their learning path, which is crucial for intrinsic motivation.
- b. **Tailored Learning Paths:**
Systems respond to individual students by creating structured learning paths according to their unique needs, interests, and aspirations (Rattadilok et al., 2019).
- c. **Focus on Meta-learning and Self-regulation:**
Personalized learning environments, especially those incorporating adaptive features, encourage meta-learning and self-regulated learning, which are vital for lifelong learning.
- d. **Continuous Assessment and Data-driven Adaptation:**
The integration of continuous, evidential, and informative assessment allows for timely and adaptive adjustments to the learning experience.

Table 3: Personalized Learning Principles (SCARCETIME)

Principle (SCARCETIME)	Meaning
Student Voice	Learners have input into the learning process
Choice	Learners can choose paths/resources
Authenticity	Learning tied to real-world relevance
Reflection	Students reflect on their own learning
Challenge	Tasks stimulate deep thinking
Engagement	Activities foster emotional and intellectual engagement
Time	Pacing suited to individual learning speed
Information	Content accessible and appropriate
Mastery	Opportunities for repeated practice
Evaluation	Continuous and personalized assessment

10.3 Challenges and Gaps in Current Implementations

The literature review also highlighted persistent challenges that the proposed framework aims to address:

- Lack of Awareness and Expertise:**
Educators often lack awareness of available online platforms for gamification and the necessary ICT skills to design interactive materials (Ab Rahman et al., 2019; Embi, 2011).
- Time Constraints in Design:**
Designing effective gamified courses is a "demanding task" (Tolentino, 2019), hindering lecturers due to workload and lack of preparation time (Jamia'an, 2010; Saggah et al., 2020).
- Motivational Gaps for Educators:**
A significant number of lecturers lack motivation to fully embrace online learning tools due to insufficient training, poor technical support, and preference for traditional methods (Embi, 2011; Embi et al., 2012).
- Limited High-Quality Adaptive Content:**
There is a general lack of high-quality, interactive, and adaptive online learning content, often due to financial factors and expertise gaps.

11. Analysis

This section presents the proposed conceptual framework, integrating the key components and principles identified in the literature synthesis (Section 10) to address the defined problems and achieve the study's objectives.

11.1 Proposed Conceptual Framework for Adaptive Gamified Learning

The proposed conceptual framework for adaptive gamified learning in polytechnic programming courses is structured around three interconnected core dimensions: Learner Profiling & Adaptation Engine, Dynamic Gamification Mechanics, and Personalized Learning Pathways. These dimensions operate in an iterative cycle to provide a continually optimized learning experience, as illustrated in Figure 3.

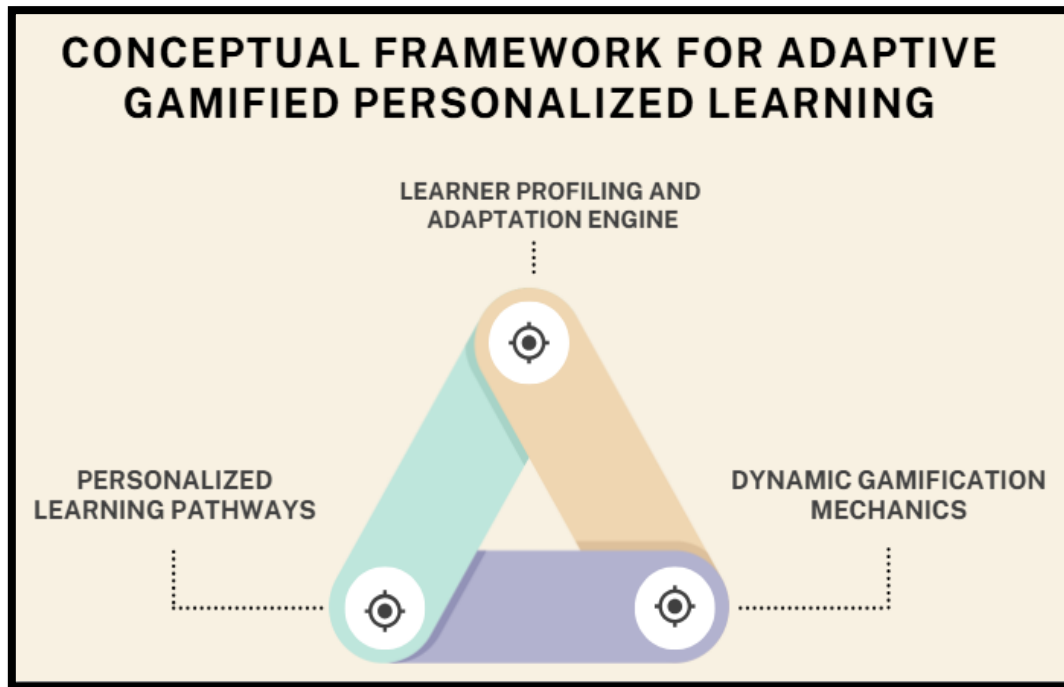


Figure 3: Conceptual Framework for Adaptive Gamified Personalized Learning

It should visually represent the three core dimensions and their interconnections, showing a feedback loop for continuous adaptation. An example layout could be a central "Learner Profiling & Adaptation Engine" feeding into "Dynamic Gamification Mechanics" and "Personalized Learning Pathways," with feedback loops from both back to the "Engine" based on learner interaction data.)

a. **Learner Profiling & Adaptation Engine:**

This dimension is central to the adaptive nature of the framework. It involves continuous collection and analysis of student data to create comprehensive learner profiles. Data points will include:

- i. **Prior Knowledge & Skills:** Assessed through diagnostic activities.
- ii. **Learning Styles:** Identifying preferences (e.g., visual, auditory, kinesthetics) to adapt content delivery.
- iii. **Player Types/Personality Traits:** Categorizing learners (e.g., Achievers, Explorers, Socializers, Killers as per Bartle's taxonomy, or other relevant player models) to tailor gamification elements that resonate most with their motivational drivers (El-Shorbagy et al., 2020).

- iv. **Engagement & Performance Data:** Real-time monitoring of interaction with learning materials, progress in gamified activities, and performance on assessments (Lopez & Tucker, 2020). The adaptation engine utilizes this profile to dynamically adjust the learning experience.

b. **Dynamic Gamification Mechanics:**

This dimension outlines the core gamification elements that will be adapted based on the learner's profile. Unlike static gamification, these elements will evolve to maintain engagement and provide targeted motivation:

- i. **Adaptive Challenges & Quests:** Tasks and problems in programming will be presented with varying levels of difficulty or structure based on the student's current proficiency and preferred player type (Codish & Ravid, 2014).
- ii. **Tailored Rewards & Recognition:** Points, badges, and virtual currency will be awarded not just for completion, but for mastering specific concepts or demonstrating desired behaviours (e.g., persistence, collaboration). The type of reward might adapt to the learner's preference (Filipcik & Bielikova, 2014).
- iii. **Personalized Progress Visualizations:** Dashboards and progress bars will show individual progress, not just against peers but against their own learning goals.
- iv. **Intelligent Feedback System:** Immediate and constructive feedback will be personalized, guiding students through programming errors or conceptual misunderstandings.
- v. **Dynamic Narrative/Storylines:** For programming concepts, a narrative might adapt its complexity or focus to suit the learner's engagement style.

c. **Personalized Learning Pathways:**

This dimension focuses on the instructional design and delivery, which is dynamically shaped by the adaptive engine and gamification mechanics:

- i. **Flexible Content Sequencing:** Learning modules or topics in programming (e.g., data structures, algorithms, object-oriented programming) can be rearranged or presented with different emphasis based on individual needs and interests (Sáiz-Manzanares et al., 2019).
- ii. **Varied Learning Resources:** Students will be offered a selection of resources (e.g., video tutorials, interactive simulations, coding exercises, written explanations) adapted to their learning style and proficiency.
- iii. **Self-Paced Progression with Adaptive Pacing:** While students can progress at their own pace, the system can provide adaptive nudges or challenges to maintain optimal learning flow (Ward, 2020).
- iv. **Collaborative & Social Learning Opportunities:** The framework will integrate gamified collaborative activities that can be personalized for group formation and role assignment, fulfilling the social interaction aspect (Kim et al., 2015).

11.2 Integration and Conceptual Validation

This framework integrates adaptive gamification and personalized learning by placing the learner at the centre. The Learner Profiling & Adaptation Engine continuously informs the Dynamic Gamification Mechanics, which in turn shape the Personalized Learning Pathways. This iterative loop ensures that the learning experience is continually adjusted to maximize engagement, motivation, and ultimately, achievement in programming.

The proposed framework directly addresses the research questions by:

- a. Identifying suitable components for an adaptive gamification design model (Learner Profiling, Dynamic Gamification Mechanics, Personalized Learning Pathways).
- b. Illustrating how these components can be integrated into a cohesive design model for adaptive gamified learning.
- c. Proposing a rigorous expert validation process (Phase 5 of Methodology) to assess the framework's clarity, coherence, and applicability.

11.3 Novelty and Contribution of the Framework

This conceptual framework differentiates itself from existing models by explicitly integrating adaptive mechanisms across both gamification elements and personalized learning pathways within the specific context of polytechnic programming education. While prior adaptive gamification frameworks (e.g., Rozi et al., 2019) and others (Hassan et al., 2019; Codish & Ravid, 2014; Filipcik & Bielikova, 2014; Kim et al., 2015; Böckle et al., 2018) have been proposed, this framework offers a detailed conceptual blueprint for how such adaptation can be systematically applied to address the unique challenges of programming courses in technical vocational education and training (TVET) environments. It contributes a pedagogical design guide for future online learning tool development that aims to reduce lecturer burden and increase student engagement and mastery.

12. Discussion

The development of this conceptual framework for adaptive gamified learning based on personalized learning holds significant implications for polytechnic programming education in Malaysia. The integration of adaptive gamification and personalized learning is crucial for successful learning and future graduate employability, as innovative methodologies in blended learning environments enhance employability (Sáiz-Manzanares et al., 2019).

12.1 Implications of the Proposed Framework

The proposed framework offers several theoretical and practical implications:

- a. Addressing Lecturer Challenges:

By guiding the design of intuitive instructional aids, the framework directly addresses the identified problems of lecturer time constraints in preparing materials and lack of programming skills. A well-designed tool based on this framework could simplify creation, potentially boosting lecturer motivation to adopt online learning.

b. Enhancing Student Engagement and Motivation:

By adapting gamified elements and learning pathways to individual student profiles, the framework is poised to significantly increase student engagement and motivation, particularly in challenging subjects like programming. This aligns with findings that gamification positively impacts engagement in the short term (Loureiro et al., 2021).

c. Promoting Deeper Learning and Achievement:

Personalised and adaptive approaches can cater to different thinking skills and learning paces, fostering a more active and receptive learning environment. This could lead to improved understanding and critical thinking among students, especially in difficult subjects.

d. Informing Policy and Curriculum Development:

The insights derived from this framework can be valuable for policy planners in reviewing and revamping ICT policies to overcome challenges in technology integration in education. It can inform curriculum adjustments to better incorporate adaptive and gamified methodologies.

12.2 Relationship to Existing Theoretical Frameworks

The proposed conceptual framework builds upon and extends existing theoretical understandings of adaptive gamification. While frameworks by Rozi et al. (2019) and others (Hassan et al., 2019; Codish & Ravid, 2014; Filipcik & Bielikova, 2014; Kim et al., 2015; Böckle et al., 2018) identify core elements of adaptive gamification, our framework explicitly integrates these with comprehensive personalized learning principles (SCARCETIME) within the specific pedagogical context of polytechnic programming. This specificity aims to provide a more actionable guide for practitioners and developers in this niche. The emphasis on user profiling for adaptation, as highlighted by Lopez & Tucker (2020), is central to our proposed framework, ensuring that adaptation is truly meaningful for individual learners.

12.3 Conceptual Validation and Future Research Directions

The next critical step for this conceptual framework is its rigorous validation through expert review (Phase 5 of the Methodology). This qualitative validation will ascertain the framework's clarity, comprehensiveness, internal coherence, and practical applicability to ensure its theoretical soundness before any empirical development. Expert feedback will be instrumental in refining the framework.

Following conceptual validation, future research will involve the empirical validation of this framework. This includes:

a. Prototype Development:

Designing and developing a functional prototype of an adaptive gamified learning application based on this framework for a specific programming course in a Malaysian polytechnic.

b. Pilot Study:

Conducting a pilot study to test the usability, functionality, and initial impact of the prototype on a small scale.

- c. **Large-scale Empirical Study:**
Implementing a quasi-experimental or experimental study with a larger sample size of polytechnic students and lecturers to rigorously evaluate the framework's effectiveness in terms of student achievement, engagement, motivation, and lecturer satisfaction. This would involve quantitative methods such as surveys and pre-post-tests (e.g., using a 5-point Likert scale questionnaire adapted from Rafidah Ab. Rahman et al., 2018) and experimental designs (e.g., Non-equivalent (pre-test and post-test) Control Group Design, with data analysed using SPSS).
- d. **Longitudinal Studies:**
Investigating the long-term effects of using such adaptive gamified learning systems on student retention, deeper learning, and career readiness.

These future research efforts will provide empirical evidence to support the theoretical propositions of this conceptual framework and guide its practical implementation in educational settings.

13. Conclusion

Gamification has indeed a positive impact in education and is suitable to be implemented, in line with the development of ICT can now be a catalyst for the use of digital games in learning. However, to ensure the perfect implementation, benefit the learners and achieve the learning objectives, then the equipment, resources and related materials need to be equipped as well as the skills and preparation of lecturers. This conceptual framework aims to provide a robust foundation for future development and empirical validation of an adaptive gamified learning system in the context of polytechnic programming courses. It systematically integrates personalized learning principles with adaptive gamification mechanisms, offering a theoretically sound and contextually relevant guide for enhancing teaching and learning in technical education.

14. References

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