THE GAMIFICATION EFFECT ON STUDENT ACHIEVEMENT, INTRINSIC MOTIVATION, ENGAGEMENT, AND THEIR RELATIONS WITH COMPUTATIONAL THINKING IN A SCRATCH PROGRAMMING ENVIRONMENT

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by

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LIST OF ABBREVIATIONS

ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
CT	Computational Thinking
DICT	Digital Information and Communication Technologies
GAET	General Administration for Educational Technology
ICT	Information and Communication Technology
IM	Intrinsic Motivation
IMI	Intrinsic Motivation Inventory
OOP	Object-Oriented Programming
SDT	Self-Determination theory

LIST OF APPENDICES

KESAN GAMIFIKASI TERHADAP PENCAPAIAN PELAJAR, MOTIVASI INTRINSIK, PENGLIBATAN, DAN HUBUNGAN MEREKA DENGAN PEMIKIRAN KOMPUTASIONAL DALAM PERSEKITARAN PENGATURCARAAN *SCRATCH*

ABSTRAK

Pelajar menghadapi kesukaran untuk memahami dan mengabstrakkan prinsip teras pengaturcaraan ke arah penyelesaian masalah. Tanggapan mereka terhadap kesukaran pembelajaran pengaturcaraan menyebabkan penurunan motivasi dan pengasingan semasa sesi kelas. Lebih-lebih lagi, ini membawa kepada pencapaian rendah pelajar semasa belajar pengaturcaraan. Berdasarkan isu ini, kajian semasa menyiasat kesan gamifikasi elemen seperti lencana, mata dan papan pendahulu terhadap pencapaian pelajar, motivasi intrinsik, dan penglibatan dalam persekitaran pengaturcaraan *Scratch* dan hubungannya dengan pemikiran komputasional. Pendekatan kaedah campuran telah digunakan dalam kajian penyelidikan. Dalam reka bentuk penjelasan berurutan ini, kedua-dua data kuantitatif dan kualitatif dikumpulkan dalam dua peringkat selama 12 minggu, dengan data dikumpulkan melalui soal selidik dan ujian diedarkan kepada 54 pelajar pertengahan gred tiga yang berada dalam dua kumpulan di mana setiap kumpulan mempunyai 27 pelajar. Pelajar dari kumpulan eksperimen mempelajari pengaturcaraan dengan gamifikasi, manakala mereka dari kumpulan kawalan mempelajari pengaturcaraan tanpa gamifikasi. Analisis tematik telah dijalankan terhadap data kualitatif. Keputusan menunjukkan bahawa gamifikasi telah terpengaruh motivasi intrinsik, penglibatan dan pencapaian pelajar dengan ketara. Juga, tidak ada hubungan antara motivasi intrinsik dan kemahiran berfikir komputasional, manakala terdapat hubungan antara penglibatan dan kemahiran

berfikir komputasional. Selain itu, analisis tematik menunjukkan bahawa kebanyakan pandangan pelajar adalah positif mengenai pengaruh ciri gamifikasi terhadap penglibatan dan motivasi mereka. Secara keseluruhan, gamifikasi menunjukkan hasil yang besar yang diselaraskan dengan perbincangan kajian literatur. Peningkatan itu didapati dalam penglibatan, pencapaian, dan motivasi intrinsik pelajar yang menggunakan gamifikasi. Terdapat perbezaan dalam pendapat pelajar tentang kelebihan penglibatan dan motivasi intrinsik di kalangan aplikasi. Kajian ini menunjukkan kebaharuan penggunaan gamifikasi bersepadu dengan pendekatan pembelajaran yang dianggap teras menyokong kurikulum sekolah. Secara konklusifnya, peluang pembelajaran untuk pengaturcaraan dalam kalangan pelajar peringkat sekolah menengah boleh dikembangkan dengan ketara dengan menggunakan ciri gamifikasi dalam persekitaran pengaturcaraan *Scratch* dalam konteks yang berbeza. Oleh itu, adalah disyorkan agar guru sains komputer di sekolah menengah Arab Saudi menggunakan ciri gamifikasi dalam persekitaran pengaturcaraan *Scratch* dalam mengajar pengaturcaraan pengenalan.

THE GAMIFICATION EFFECT ON STUDENT ACHIEVEMENT, INTRINSIC MOTIVATION, ENGAGEMENT, AND THEIR RELATIONS WITH COMPUTATIONAL THINKING IN A SCRATCH PROGRAMMING ENVIRONMENT

ABSTRACT

Students faced difficulties in comprehending and abstracting the core principles of programming toward problem-solving. Their impression of the programming learning difficulties causes demotivation and disengagement during class sessions. Moreover, these further lead to the low achievement of the students when learning to program. Based on this issue, the current study investigated the effects of gamification elements such as badges, points, and leaderboards on student achievement, intrinsic motivation, and engagement in a scratch programming environment and its relationship with computational thinking. A mixed-method approach was used in the research study. In this explanatory sequential design, both quantitative and qualitative data were gathered in two stages during 12 weeks, with data being collected via questionnaires and tests distributed to 54 third-grade intermediate students who were into two groups where each group had 27 students. The students from the experimental group learned programming with gamification, whereas those from the control group learned programming without gamification. Thematic analysis was carried out on the qualitative data. Results showed that gamification significantly influenced the students' intrinsic motivation, engagement, and achievements. Also, there is no relationship between intrinsic motivation and computational thinking skills, while there is a relationship between engagement and computational thinking skills. Moreover, the thematic analysis showed that most

students’ views were positive regarding gamification elements' influences on their engagement and motivation. Overall, gamification showed substantial outcomes harmonized with discussions of literature studies. The enhancement was found in the students’ engagement, achievement, and intrinsic motivation who adopted gamification. Conclusively, learning opportunities for programming amongst intermediate school students could be expanded significantly by using gamification elements in Scratch programming environments in different contexts. Therefore, it is recommended that computer science teachers in Saudi Arabia intermediate schools adopt gamification elements in the Scratch programming environment in teaching introductory programming.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Formulating solutions using problem-solving methodologies with Scratch programming language in a manner that machines can effectively interpret is considerably more simplistic than acquiring programming skills (Kadar et al., 2021). This task necessitates the acquisition of supplementary proficiencies, such as programming, a comprehensive understanding of programming language syntax, and algorithm development (Baist & Pamungkas, 2017). Intermediate school students' perceptions and skills to grasp the fundamentals of language syntax and to comprehend the language's structure and style are impacted by this complexity. According to Gomes et al. (2018), beginner students typically face substantial obstacles in basic programming classes, mainly when they are in middle school. Students generally are demotivated to study with an open mind due to these problems in learning Scratch programming that cause them to have a wrong opinion (Kadar et al., 2021).

Motivation has a tremendous impact on students' participation in the learning process and the area of education in general, which results in high-quality instruction (Ryan & Deci, 2000). Students' motivation could be low or high; students associated with low motivation in learning tend to be class truants. However, students characterized by high motivation tend to be fully committed through hard work, dedication, persistence, and endurance during learning sessions (James & Brad, 2014). Furthermore, Koivisto and Hamaria (2019) note that there exist two primary types of motivation, namely extrinsic motivation, which students emphasize the most, and intrinsic motivation, which refers to engagement in inherently satisfying or pleasurable behavior. Mekler et al. (2017) posit that intrinsically motivating behavior is characterized by engaging in enjoyable activities. Consequently, the primary focus of this study revolves around the impact of gamification on students' intrinsic motivation.

Achievement in educational research is a variable that determines students' decisions concerning learning programming outcomes (Lee et al., 2023; Sercemeli & Baydas, 2023; Tuominen-Soini et al., 2011). Thus, it has been examined by previous similar research as a significant determinant of motivation and performance generally (Elliot et al., 1999; Groening & Binnewies, 2019). Perhaps, achievement in a typical learning setting is the core motive for attaining students' absolute achievement behavior (Al-Abyadh et al., 2022; Aljraiwi, 2019; Joy et al., 2013). According to the assertion, researchers have demonstrated that students' achievement determines the extent of their academic performance, giftedness, and ability to comprehend and learn almost immediately after learning sessions (Nemeth & Long, 2012).

Computational thinking is a valuable aid in enhancing students' learning abilities, thereby facilitating the development of problem-solving skills for both programming learners and students (Lawanto, 2016; Zhang & Nouri, 2019). This is why CT has been promoted as a significant requirement and prerequisite 21st-century learning skill by researchers and professional computer scientists (Tikva & Tambouris, 2020; Wing, 2008) since it is linked to the "4 Cs" of creativity, critical thinking, communication, and cooperation (Binkley et al., 2012; Kerimbayev et al., 2023). Thus, some perceive computational thinking as problem-solving or designing and developing new programs to understand human behavior (Stewart et al., 2021; Tatar, 2019; Wing, 2008). According to several scholars, the concept of computational thinking holds significant importance in the field of computer science primarily including using computer science ideas to tackle problem-solving (Andrew et al., 2015; Krauss & Prottsman, 2017; Junhyeong & Hyeongok, 2018; Joshua, 2017; Soboleva et al., 2021).

Additionally, the present investigation focused on the capacity to incorporate gamification elements in programming education to augment student engagement. Several studies have demonstrated that the inclusion of gamification elements leads to higher levels of increasing motivation, engagement, and competitiveness. in K-12 education (Dehghanzadeh et al., 2023; Huotari & Hamari, 2017; Koivisto & Hamaria, 2019). Thus, this study examines the relationship between students' intrinsic motivation, engagement, and computational thinking of Saudi third-intermediate students. The literature provides a limited understanding of gamification versus non-gamification elements' influence on learning outcomes. This particular study endeavors to bridge the gap in the literature by conducting a comparative analysis of gamification's efficacy in enhancing student engagement, motivation, and achievement among intermediate students in Saudi Arabia.

1.2 Background of the Study

Computer programming has become a critical topic within the curricula of Computer Science. It is important to note that a significant number of students at the middle, secondary, and higher education levels find it to be a particularly challenging area of study. This difficulty is, in part, due to the abstract concepts that are a fundamental aspect of programming development, which students often perceive as particularly challenging. The majority of issues arise when students must demonstrate their mastery of abstracting programming logic processes, particularly when utilizing object-oriented programming (OOP) concepts, which they find conceptually challenging (Butler & Morgan, 2007). The impression that students have of the challenges of learning programming can lead to demotivation and disengagement during class sessions. This may ultimately result in substandard academic performance when acquiring programming skills (Alakeel, 2015).

According to Kaui and Asi (2011), Scratch is a free programming language that was first designed with block capabilities that include blocks and separators, making it simple for learning programmers to build animated stories and visual arts projects. The block characteristics of the Scratch programming environment help novices and students learn and teach programming languages. It further supports various gamification and programming tasks, especially at the initial programming learning stage (Filiz & Yasemin, 2014). Moreover, the availability of Scratch as a user-friendly and block-based programming environment has motivated computer science teachers (Sze & Joyce, 2014).

Certain block elements in the Scratch programming environment, especially drag-and-drop blocks, and sprites, offer significant advantages to programming learners in developing new mathematical and computational thinking skills (Kereki, 2008). This, in turn, reduced the challenges and computational or cognitive load faced by computer science students and programming learners (Garner, 2009).

Students need to drag and drop or snap the command blocks in the Scratch programming environment; this helps them concentrate more on the logical and structural components rather than thinking about machine language (Kelleher & Pausch, 2005). Most importantly, adding gamification elements to the Scratch programming, such as scores, tasks, levels, badges, rewards, points, and leaderboards, would significantly boost the students' motivation, engagement, and achievement (Deterding et al., 2011). Similarly, Sze and Joyce (2014) further posited that gamification elements and related block programming environments assist students in gaining computational practices and dimensions of computational thinking because the project created can be seen in an animated form. As a result, the students become proficient at solving computational problems, which reduces the cognitive difficulty of computational tasks like testing and debugging.

Gamification is a technological process that involves comprehending, organizing, and implementing a gamified task into a context (Huotari & Hamari, 2017; Liu et al., 2017). Gamification is defined as the incorporation of game design elements in contexts beyond games (Deterding et al., 2011, P.9). This approach employs game design elements to transfer the motivational factors engendered by games to more routine activities, effectively enhancing their appeal and interest (Deterding et al., 2011). Commonly used game design elements in gamification include avatars, ranks, leaderboards, levels, point systems, competition and challenges, narrative, and badges, among others (Deterding et al., 2011; Landers & Armstrong, 2017).

Given the increasing popularity of the use of gaming in education and the fact that player engagement can be induced by gaming, gamification, and serious games have emerged across various sectors (e.g., business and education) and disciplines (e.g., computer science and mathematics) to engage and motivate users in target activities (Mitchell et al., 2020; Ortega-Arranz et al., 2019). An increasing number of empirical studies have been conducted on gamification in education. Gamification helps improve students’ learning, e.g., by increasing motivation, engagement, and learning achievement. For example, the implementation of gamification incorporating various elements such as points, medals, and ranking has been shown to impact students' motivation and engagement of the learners (Alsawaier, 2018; Smiderle et al., 2020). These game modules include scores, tasks, levels, badges, rewards, points, and accomplishments (Deterding et al., 2011).

Games typically comprise two primary elements: game mechanics, which entail points, levels, badges, virtual goods, gifts, or leaderboards, and game dynamics, which include rewards, status, achievement, self-expression, or altruism (Khaleel et al., 2016). The identification of gamification elements, namely points, levels/stages, badges, leaderboards, prizes and rewards, progress bars, storyline, and feedback, within gamified intelligent educational systems (Nah et al., 2014).

Intrinsic motivation is a measuring instrument used to examine the users' experience based on the tasks or activities carried out. The instrument scale was used to identify the participant's interest/enjoyment, perceived competence, effort, perceived choice, value, and pressure faced or felt during an activity or task (Deci & Ryan, 1985). The use of these game elements serves as a technique to enhance user engagement, motivation, and attention among students (Aparici et al., 2012; Koivisto & Hamaria, 2019; Oliveira et al., 2022). Student engagement has been defined as comprised of four elements: cognitive engagement, agentic engagement, emotional engagement, and behavioral engagement (Fredricks et al., 2004; Huang et al., 2022). Chans and Portuguez Castro (2021) indicated that gamification increased student motivation and engagement, improved attitudes, promoted actions such as keeping the camera on during lectures and regular attendance, and improved student grades. Subsequently, using game elements, such as points, badges, and leaderboards in the Scratch programming environment primarily entails using game modules to learn objectives to motivate and engage students throughout the learning process properly.

Previous research has regarded gamification as a practical didactic approach that facilitates the development of students' professional competencies, encourages a sense of community, improves the acquisition of content knowledge, and enhances students' level of engagement (Alsawaier, 2018; Chans & PortuguezCastro, 2021). Additionally, Gede et al. (2018) have argued that the incorporation of gamification elements in programming learning can directly and positively impact students' motivation and achievement. They have also claimed that gamification is particularly beneficial when teaching programming languages to young learners due to its simplicity and entertaining elements, which make the learning process more exciting and engaging. Previous scholarly investigations have suggested that gamification can be a pedagogical approach that amplifies students' vocational skills, fosters a sense of community, cultivates superior cognitive comprehension, and heightens engagement (Jurgelaitis et al., 2019). It is worth noting that previous research has indicated that gamification elements have been primarily associated with video game characteristics and need satisfaction (Gede et al., 2018; Kesler et al., 2021; Koivisto & Hamaria, 2019) on the one hand and other relevant constructs such as intrinsic motivation on the other hand (Alsadoon et al., 2022; Alsawaier, 2018).

Although some theories and models have attempted to conceptualize motivation, Self-Determination Theory (SDT) is arguably the well-researched psychological theory of intrinsic motivation. Students with intrinsic motivation tend to encounter a sense of investment and satisfaction. Moreover, they tend to feel proficient and possess a self-determining attitude. Such individuals perceive the locus of causality for their behavior to be internal. On rare occasions, they may even experience a state of flow, as determined by Deci and Ryan (1985). Likewise, certain studies have demonstrated that gamification is incorporated into hedonistic systems and software, intensifying students' intrinsic motivation, engagement, and achievement through entertainment (Koivisto & Hamaria, 2019).

According to the principles of the flow theory, students experience a state of engagement known as Flow. This state is characterized by a sense of comfort and immersion in task completion, where one can become so fully absorbed in the activity at hand as to disregard peripheral stimuli (Csikszentmihalyi, 1990). Engagement factors from the perspective of engagement theory can be seen from the participation and involvement of students in an activity or learning task (Fredricks et al., 2004). Therefore, it can be said that gamification affects their levels of engagement (Huotari & Hamari, 2017).

The Saudi Arabian middle school curriculum offered the possibility of integrating elementary coding components into their current teaching structure. Recent curriculum modifications have resulted in the inclusion of programming as a mandatory subject matter. The compulsory computing courses that encompass programming will now be required for both male and female students in middle and high schools. However, the low participation of Saudi Arabian students in computing has been an enduring challenge, both within and beyond the school system (Alebaikan et al., 2022). One of the aspects of this research would involve using Scratch programming with gamification elements to test Saudi third-grade students' achievement, motivation, and engagement toward computational thinking.

Computational thinking is one of the primary learning skills in the 21st (twenty-first) century. Computational thinking, which implies the ability to solve problems algorithmically and logically, is one of the factors in digital learning (Kerimbayev et al., 2023). Computational thinking, as promoted by Wing (2006), involves applying basic computer science concepts that can be considered fundamental knowledge for intermediate school students since it requires thinking of multiple abstractions (Brennan & Resnick, 2012). Introducing programming into computer science subjects at the middle school level exposes the students to computational thinking strategies such as abstraction and decomposition. Computational thinking skills are incredibly beneficial even for non-computing students since they are used in solving classroom and day-to-day problems. Computational thinking covers thinking processes that participate in the problem statement and provides a solution that a human or a computer can effectively realize. Children can learn how to use computational thinking without a computer (Kuo & Hsu, 2020), for example, while playing a board game, which corresponds to structural programming (Kerimbayev et al., 2023).

Furthermore, all educational experts concur that computational thinking fosters creativity, problem-solving skills, achievement, and critical thinking, all essential 21st-century learning skills (Ananiadou & Claro, 2009; Binkley et al., 2012; Sze & Joyce, 2014). As a result, it is not surprising that researchers have advocated for the inclusion of introductory programming in intermediate and secondary school computer science curricula (Kafai & Burke, 2013; Margolis et al., 2011; Resnick et al., 2009). Few previous studies point out that student motivation is a fundamental and important factor in linking students to computational thinking (Gong et al., 2021; Kaur & Chahal, 2023). Hence, the researcher intends to investigate the effects of gamification elements on achievement, engagement, and intrinsic motivation. This research also addresses the gap in the existing literature by adding important information regarding engagement, intrinsic motivation -classroom, and students' computational thinking in a Scratch programming environment in Saudi Arabia.

1.3 Preliminary Study

The primary objective of the preliminary study is to investigate the various challenges and difficulties that computer teachers face when teaching students Scratch programming. Eight computer science instructors of intermediate third-grade students in Saudi Arabia were questioned using an interview procedure instrument that the researcher had developed. The present study focuses on instructors instead of students for several reasons. Firstly, it has been determined that instructors are well-versed in the challenges students face when learning programming in computer-based lessons. Secondly, students may not necessarily be aware of these difficulties or may not be apt to express them explicitly, as is the case with instructors. Lastly, as instructors have extensive experience working with students of various skill levels, it is anticipated that the outcomes will be precise due to this accumulated expertise.

Appendix A contains the letter of evidence for the preliminary study. The questions are developed to allow the interviewee to discuss the topic in detail. The researcher asked the teacher some questions that included the challenges and difficulties computer teachers faced when teaching students Scratch programming. After analysis, there were three categories of themes: Scratch for Teaching Programming, Understanding Programming Based on Scratch, and Computational Thinking Skills by Learning Scratch. Table 1.1 below presents the themes identified during the preliminary study. The information gathered from the eight interviews was examined (Appendices B and C).

Table 1.1 Categories of the Themes for the Preliminary Study

Themes	Sub-themes
Scratch for Teaching Programming	- The Use of Scratch for Teaching Programming - Understanding programming using Scratch
Understanding Programming Based on Scratch	- Whether the Students understand the concept of Scratch - Learning Programming using Scratch is difficult
Computational Thinking Skills by Learning Scratch	- Improvement in Student's Programming Language by learning Scratch

The researcher recorded the following from the participants' responses, as summarized in Table 1.2 below:

Table 1.2 Summary of Findings from Preliminary Study Interview Based on Category

Category	Summary of Findings from Preliminary Study Interview
Difficulties in understanding the fundamental concepts of Scratch programming	According to the computer teachers, a majority of the students encountered difficulties in understanding the fundamental concepts of Scratch programming. Others are not interested in learning Scratch programming and computer subjects, and I think they feel it is difficult.
Understanding Programming Based on Scratch	According to several computer professors, because the Scratch programming environment is difficult to comprehend, students are typically reluctant to practice programming with it. The real notion of programming was most likely to be difficult for students to understand.
Computational Thinking Skills by Learning Scratch	Other computer professors reported that the students were struggling with computational thinking because they were unable to break down larger issues into smaller ones to solve them. Additionally, while utilizing the Scratch programming environment, some of them approach problems incorrectly.

1.4 Problem Statement

Programming is essential to the computer science curriculum, yet it challenges many students. The intricate nature of programming demands exceptional effort, impeding students' ability to learn programming (Azad & Smith, 2014; Gomes et al., 2018; Islam et al., 2019). According to Lee et al. (2023), middle school students regard "uncertainty" and "complexity" as the most significant challenges in computer programming. Additionally, the lack of technical skills among students hinders their ability to download programs on their devices accurately. It deprives them of the opportunity to practice and apply practical skills (Alsadoon, 2022).

According to data from past research, many students struggle with programming in the early learning stage. However, for some students, it takes middle school to comprehend and abstract the basics of programming toward problem-solving (Gomes et al., 2018; Lee et al., 2023). Additionally, earlier research has demonstrated the learning severity of students' programming challenges in the early years of school (Butler & Morgan, 2007; Cheah, 2020). Because abstract notions are a necessary component of programming development, students view computer programming as challenging. Some of these learning obstacles in programming are typically connected to issues with an abstract notion, which is a necessary condition for creating programming. Most of the issues were noticed when the students had to prove their proficiency with abstracting (Daher et al., 2020). Students' impression of the programming learning difficulties causes demotivation and disengagement during class sessions. Moreover, these further contribute to the student's low achievement when learning to program (Alakeel, 2015; Lee et al., 2023).

A crucial aspect has been choosing a suitable and adequate programming environment for the students' desired phases. This is because the programming environment ought to overcome achievement and engagement challenges, which usually cause a lack of motivation among students (Grover & Pea, 2013). Traditional non-visualized programming environments typically rely on languages that need strong computational and problem-solving abilities, most frequently taught by solving challenging mathematical problems (Christopoulos, 2018).

Contrarily, the block-based Scratch programming environment has no grammar errors, which appeals to students more (Monika et al., 2017). Additionally, Scratch is a programming environment that is more accessible and suitable for young people and novice learners since it is a block-code environment. Resnick et al. (2009) assert that novice programmers, particularly those in middle school, encounter significant challenges in acquiring and mastering programming skills. This is due to the necessity of initially decomposing complex programming tasks into smaller, more manageable units to surmount those (Monika et al., 2017) effectively.

Resnick et al.'s (2009) findings also revealed that most students had trouble studying programming in the Scratch environment. The findings also proved that almost all the students had enormous challenges in comprehending the actual programming concept in the Scratch environment due to the limited frequency of teaching such concepts in classes within teaching hours or periods. Due to persistent challenges, some students had grown weary of studying computer science and programming concepts using the Scratch programming language.

Simply presenting the scenario as a game or play session using gamification characteristics can potentially alter students' learning ambitions (Hakak et al., 2019; Lieberoth, 2015; Zainuddin et al., 2020). Gamification elements may also encourage students to gain programming skills, especially using the Scratch programming language. Gamification is an influential tool teachers may use to inform, inspire, encourage, and increase student engagement and enhance learning (Kotani & Tzelepi, 2015; Qiao et al., 2023). A gamification application in K-12 education, for instance, promotes understanding and improves student achievement, motivation, and engagement (Dehghanzadeh et al., 2023; Zainuddin et al., 2020).

According to published research, gamification elements were particularly achievement in increasing students' enthusiasm for teaching computer science and information communication courses like beginner computer programming (Gomes et al., 2018; Lieberoth, 2015; Yilmaz et al., 2017). Numerous strategies and techniques were suggested in the wake of extensive studies to lessen the problems and obstacles of learning programming by students (Gomes et al., 2018; Gomes & Mendes, 2007). Although some of the suggested solutions have had significant results, none comprehensively answer the problems students confront when programming. Given the ongoing complaints regarding the difficulties many students have had when learning fundamental programming, Gomes and Mendes (2007) they are further stated that most of these obstacles have not altered (Gomes et al., 2018). Gamification elements increase performance and engagement, improving usability, effectiveness, and fulfillment to provide a satisfying experience that motivates employees (Gonçalo & Tiago, 2019). A specific game feature or aspect may have a variety of effects.

In the context of education, the impact of gamification on motivation, engagement, and learning achievement has been examined by previous studies, and many of them show positive results (Zainuddin et al., 2020; Ofosu-Ampong, 2020). However, in the large body of research that measured the effects of gamification on students' performance, motivation, and engagement, most studies were generally descriptive after examining the literature on the research subject matter (Alsawaier, 2018; Hanus & Fox, 2015; Lasse and Tapio, 2015; Smiderle et al., 2020). The literature on the effect of gamification on motivation and gamification is still limited on multiple levels (Alsawaier, 2018).

Due to the nature of intermediate education, and the emphasis on students being self-learners, self-motivators, and self-regulators of their learning strategies, it is essential to measure gamification elements' effect on students' achievement, intrinsic motivation, engagement, and thus computational thinking at this level. The recent meta-analytic study by Sailer and Homner (2020) stressed the need for more experimental research on applying gamification and its relationship with students' achievements and motivations. This was further enforced by Dehghanzadeh et al. (2023) who call for future research on using gamification in K-12 education. Therefore, this creates another gap for future researchers to consider, focusing on the effects of gamification on learners' outcomes (Huang et al., 2020).

Furthermore, a thorough investigation of related literature reveals that students' internal motivation, engagement, achievement, and computational thinking have not been comprehensively explored at the intermediate student's school level in the Arab world and Saudi context. Most Saudi studies measure the impact on general students' performance and motivation through gamification-based platforms (Alebaikan et al., 2022; Al-Malki & Meccawy, 2022; AlZuhair & Alkhuzaim, 2022) as stated by Murillo-Zamorano et al. (2021) that most gamification studies conducted among school students and higher education contexts have remained underexamined. Hence, this study is unique in its use of the framework to comprehensively measure the gamification elements' influence on the motivation, engagement, and achievement of students. On the other hand, to date, there has been a dearth of empirical studies that have undertaken a focused inquiry into the correlation between motivation and students' computational thinking within the Scratch environment (Gong et al., 2021; Kaur & Chahal, 2023). This research effectively bridges the gap in the extant literature by providing significant insights into the role of intrinsic motivation in students computational thinking of intermediate students in Saudi Arabia.

In summary, this current study is intended to fill the gamification gap. It aims to infuse gamification into students' demotivation, disengagement, and low achievement when learning programming in Saudi Arabia. Besides that, based on the discrepancies of past research, this current study considers how gamification-based learning affects students’ achievement, engagement, and intrinsic motivation toward computational thinking in the Scratch programming environment. To accomplish this, the current Scratch teaching methodology must be revised and transformed to make it more appealing and motivating to students in intermediate school, thereby increasing their commitment to studying programming. The purpose of this study is to address the following research goals by suggesting and recommending potential solutions to the problems raised:

1.5 Research Aim and Objectives

The purpose of this study is to investigate how gamification elements, such as badges, points, and leaderboards, influence students' intrinsic motivation, engagement, achievements, and its relationship with computational thinking in the Scratch programming environment and to understand participants' views on gamification in respect of their engagement and intrinsic motivation. To accomplish the aim above and address the study issues, the following objectives are suggested;

1. To investigate the effect of gamification on students' intrinsic motivation amongst the third grades intermediate students in the Scratch programming environment.
2. To investigate the effect of gamification on students' achievement amongst the third grades intermediate students in the Scratch programming environment.
3. To investigate the effect of gamification on students' engagement amongst the third-grade intermediate students in the Scratch programming environment.
4. To examine the significant relationship of intrinsic motivation with computational thinking in a gamified group.
5. To examine the significant relationship of engagement with computational thinking in a gamified group.
6. To explore the students' views about gamification with respect to their engagement and intrinsic motivation in the Scratch programming environment.

1.6 Research Questions

The objectives of this project are to address the following research questions:

1. Is there any significant difference in students' intrinsic motivation between the gamified and non-gamified groups in a scratch programming environment?
2. Is there any significant difference in students' achievement between gamified and non-gamified groups in scratch programming environments?
3. Is there any significant difference in students' engagement between the gamified and non-gamified groups in a scratch programming environment?
4. Is there a significant relationship between intrinsic motivation and computational thinking in the gamified group?
5. Is there a significant relationship between engagement and computational thinking in the gamified group?
6. What are the students' views about gamification with respect to their engagement and intrinsic motivation in the gamified group in a scratch programming environment?

1.7 Research Hypothesis

$H_{1:}$ There is a significant difference in students' intrinsic motivation between the gamified and non-gamified groups in the Scratch programming environment

$H_{2:}$ There is a significant difference in students' achievement between the gamified and non-gamified groups in the Scratch programming environment.

$H_{3:}$ There is a significant difference in students' engagement between the gamified and non-gamified groups in scratch programming.

$H_{4:}$ There is a significant relationship between intrinsic motivation and computational thinking in a gamified group.

H5: There is a significant relationship between engagement and computational thinking in a gamified group

1.8 Theoretical Framework

In studies on gamification assessment, the sort of learning that must occur is typically stressed by utilizing learning and teaching theories. The impacts of social contact among students, or rather the effects of a socially and culturally situated environment of cognition, have been highlighted in several prior research (Duffy & Cunningham, 1996). The utilization of a gamified environment, replete with game elements such as points, badges, and leaderboards, has been noted by Deterding and Dixon (2011). In this context, assessment serves to allocate these game elements to students.

The theoretical framework known as self-determination theory, as posited by Deci and Ryan (1985), centers around the concept of intrinsic motivation. A well-known theory of motivation and personality needs encompasses competence, autonomy, and relatedness (Ryan & Deci, 2000). This theory highlights the presence of three fundamental psychological needs that, when fulfilled, serve to enhance students' intrinsic motivation: the need for enjoyment, the need for perceived choice, and the need for usefulness. As gamification involves incorporating game elements into the development of video games, it is imperative to underscore the significance of the offline or traditional classroom setting, whereby students can be exposed to these game elements. Consequently, the integration of gamification elements such as points, badges, and leaderboards aids in the identification of students' intrinsic motivation and level of engagement, ultimately leading to an improved learning experience.

Piaget's (1977) constructivist learning asserts that knowledge acquisition is best achieved through action, reflection, and construction. With a social constructivist approach, gamification facilitates collaborative work and meaningful student discussions. Constructivism theory enables learners to develop meaningful experiences by constructing knowledge with the help of their peers. Furthermore, this study establishes a correlation between constructivism, computational thinking, and academic success. With a game-based assessment, the students can either assess themselves or 1even evaluate the performance of their peers.

Engagement theory is a conceptual framework for technology-based learning and teaching. The theory of engagement proposed by Kearsley and Shneiderman (1998) has been suitably adapted as a productive model for comprehending the dynamics of student engagement in the context of game-based learning. Based on the engagement theory of Kearsley and Schneiderman (1998), to ensure a meaningful engagement towards the gamification elements and tasks, game elements were applied in the traditional classroom to allow teachers to control the elements of gamification that might be beyond learners' capacity. his allowed the students to concentrate and undertake tasks that were within the range of their competency.

The theory of flow (Csikszentmihalyi, 1998) can explain how gamification can improve students' learning, motivation, engagement, and achievement in a Scratch programming learning environment. This assertion stems from the fact that the majority of game designs emphasize a balance between the challenges and skills of players (i.e., learners). Accordingly, the incorporation of gamification elements (badging, leaderboard, and points) represents one of the easiest approaches to attaining the coveted "state of flow," (McGonigal. 2011). Indeed, one of the fundamental objectives of gamification is to utilize the principles of game design to enhance the positivity and enjoyment associated with the learning experience (Baxter et al., 2015). This reflects the difficulty underlying the nature of challenge-based gamification design, which comprises the crucial aspect of ensuring that users can achieve a state of flow.

In line with gamified approaches, flow begins with recognizing and expounding one's goals and creating actionable objectives to attain those goals (Antonaci et al., 2018; Liu et al., 2017). For instance, a game that is well-developed supports the state of flow by providing a challenging, goal-oriented activity as one moves towards an attainable, and objective goal (Moneta & Csikszentmihalyi, 1996). Students' engagement and achievement are significantly correlated with the activity's level of challenge. To summarize, challenge-based gamification may encourage a student to complete more tasks with higher motivation, a higher sense of achievement, and a better sense of learning progress, in which those elements are scrutinized through the motion in mind concept and flow theory (Anunpattana et al., 2021). Empirical research has established a significant correlation between increased levels of engagement and the adoption of gamification elements in online courses (Buckley & Doyle, 2016; Hanus & Fox, 2015).

Hence, the flow theory provides a purview to understand the relationship between gamification and intrinsic motivation, engagement, and achievement (Figure 1.1). The literature review's Section 2.3 provides a comprehensive overview of the four recognized learning theories and their connections to the study's variables.

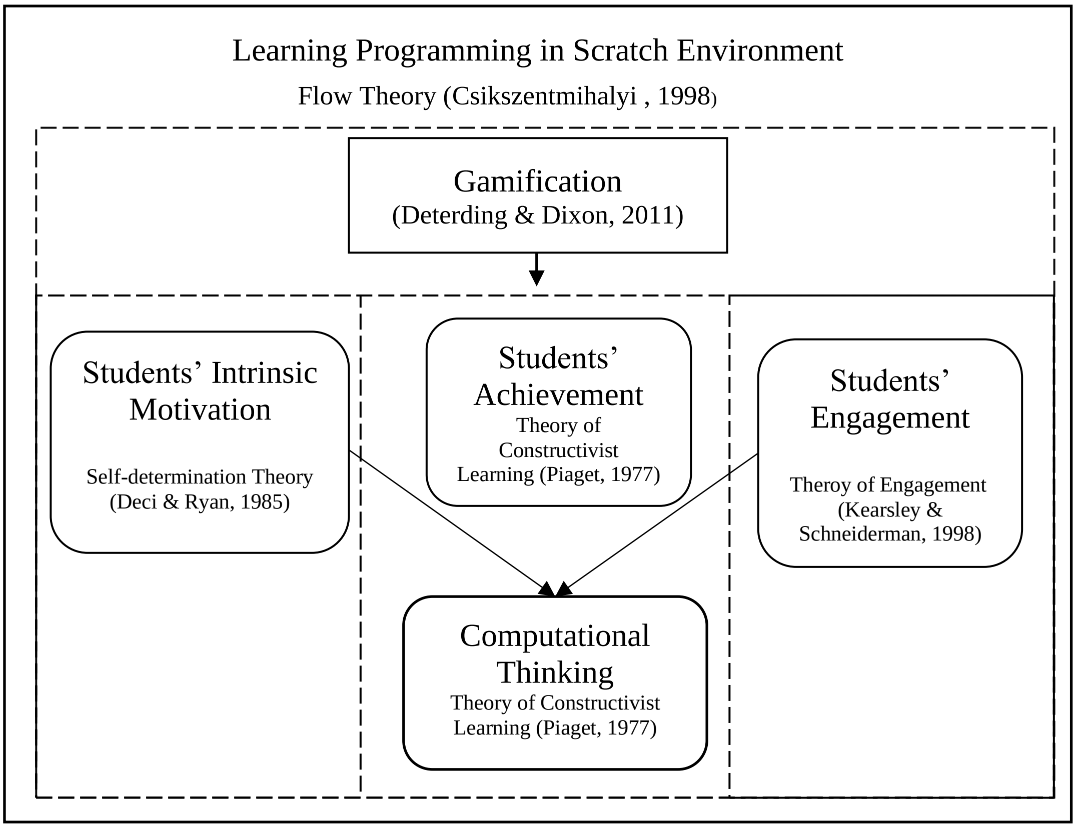

Figure 1.1 The Theoretical Framework

1.9 Conceptual Framework

The research model is shown in Figure 1.1. The effects of gamification design elements on four learning outcomes within programming education in a Scratch environment. This study aimed to examine the influence of gamification elements on intrinsic motivation, engagement, and achievement, as well as the connection between intrinsic motivation, engagement, and computational thinking among Saudi intermediate third-grade students. Briefly, the conceptual framework consists of one independent variable (IV) and four dependent variables (DVs) (Figure 1.2).

The independent variable comprises game elements found in gamification. These elements are points, badges, and leaderboards. Gamification is a relatively new learning strategy that is increasingly used in education because of its potential to increase learners' motivation and improve their achievements (Yildirim, 2017; Zainuddin et al., 2020). Student learning outcomes are the dependent variables in the study. However, student learning outcomes possess multiple dimensions. In Landers' (2015) conceptual framework of gamified learning, motivation, engagement, and cognitive learning are fundamental factors that contribute to learning outcomes. Specifically, motivation and engagement are identified as mediators of cognitive learning (Landers, 2015). In this study, cognitive learning is defined as the primary learning achievement. Therefore, this investigation focuses on the three dimensions of learning outcomes: intrinsic motivation, engagement, and achievement.

Students' intrinsic motivation is a critical element for the accomplishment of the teaching-learning process and is linked directly to gamification (Alsadoon et al., 2022; Rahayu et al., 2022). Students' intrinsic motivation is one of the most researched consequences of gameful experience and is often understood within the context of SDT (Zainuddin et al., 2020). To capture students' intrinsic motivation, self-reported measurements on how much they enjoyed the learning activity and were interested in learning the course content were used. Therefore, we identified the dependent variable as the motivation of which the studies explored the interest, usefulness, and perceived choice in gamified learning (Ryan et al., 1991).

Students' engagement is a critical element of an effective learning process, with a large body of research linking it to academic achievement (Argyriou et al., 2022; Tao et al., 2022). Engagement, which refers to how much the learners focused on learning and how involved they were in learning, was measured in four dimensions: behavioral engagement, agentic engagement, cognitive engagement, and emotional engagement (Reeve & Tseng, 2011). Students' achievement is directly related to their ability to attain their learning objectives (Erhuvwu & Adeyemi 2019). Based on the course book assessment, the achievement was often presented in the forms of knowledge of programming, conceptual knowledge, and strategic knowledge of programming. Finally, computational thinking is the outcome variable, which pertains to the fundamental problem-solving abilities that upcoming cohorts of students must acquire. (Román-González, 2015).Gamification is also believed to positively affect learners' motivation, engagement, and achievement, which influence computational thinking (Dicheva et al., 2019; Elbyaly & Elfeky, 2022; Zainuddin et al., 2020). Hence, hypotheses (H1-H3) were developed based on the objectives of this study, which are concerned with the significant differences between the student's intrinsic motivation, engagement, and achievement between the gamified and non-gamified groups. Based on the above, hypotheses (H4-H5) were developed which are concerned with the role of intrinsic motivation and engagement in computational thinking which is related to research objectives four and five.