

Ministry of Science and Higher Education of the Republic of  
Kazakhstan

Suleyman Demirel University



Lazzat Tolegen

# Gamification in Programming Language Learning

THESIS

Presented in Partial Fulfilment for the

*Master of Technical Sciences Degree in Computer Science*

(degree code: 7M06102)

Department of Computer Science

Faculty of Engineering and Natural Sciences

Supervisor: **Akerke Alseitova**

Kaskelen 2023

Suleyman Demirel University  
Faculty of Engineering and Natural Sciences  
Department of Computer Science

✓ Dean of Faculty

Associate Professor

PhD Zhamanov A.



*[Handwritten signature]*

06 2023

**Topic of the thesis:**

Gamification in Programming Language Learning

Thesis submitted as part of the requirements for the award of the MSc in  
“7M06102 - Computer Science” SDU, 2021-2023

Head of Department *[Signature]* Assistant Professor, PhD Mukash Zh.

Academic Supervisor *[Signature]* Alseitova Akerke

Master student *[Signature]* Tolegen Lazzat

Kaskelen 2023

# Declaration

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

Lazzat Tolegen

2023

# Acknowledgements

First of all, I want to thank my scientific supervisor. When I first started my Master's degree, I have known very little in my academic field. Under supervision of Ms. Alseitova during these two years, I have read and investigated numerous scientific papers on Gamification, so I have expanded my knowledge and became proficient. Secondly, I am thankful to my parents. This study was not easy, I struggled a lot, but my parents always showed me love and support.

# Dedication

This thesis is dedicated to:

My parents.

# Abstract

Gamification is widely being used in every field including education to increase motivation as one of the reasons. Learning a programming language is generally difficult as understanding abstract notions and most teachers agree that students' struggle with programming languages which then leads to lack of motivation to learn afterwards. To solve this issue a case study on the gamification of programming language class for lower secondary students studying computer science is provided and examined. During two-week experiment total of 32 8th grade students participated, and Codehs, a gamified online learning platform, employed an experimental group, whereas the control group received the traditional teaching approach. Students' motivation level was measured using the Intrinsic Motivation Inventory before and after the experiment. The findings indicated that there was significant difference in the level of intrinsic motivation observed in the experimental group, thus rejecting the null hypothesis. These findings suggest that gamification may have a major impact on intrinsic motivation in the context of learning programming language in lower secondary school.

# Аңдатпа

Себептердің бірі ретінде мотивацияны арттыру үшін геймификация барлық салада, соның ішінде білім беруде кеңінен қолданылады. Бағдарламалау тілін үйрену әдетте абстрактілі ұғымдарды түсіну қиынға соғады және мұғалімдердің көпшілігі студенттердің бағдарламалау тілдерімен қиыншылық тудыратына келіседі, бұл кейіннен оқуға мотивацияның болмауына әкеледі. Бұл мәселені шешу үшін информатиканы оқитын орта мектептің төменгі сынып оқушылары үшін бағдарламалау тілі сабағының геймификация арқылы кейс-стади ұсынылып, қарастырылды. Екі апталық экспериментте барлығы 32 8-сынып оқушылары қатысып, Codehs, геймификация онлайн оқыту платформасы эксперименттік топқа, ал бақылау тобына дәстүрлі оқыту әдісі қолданылды. Оқушылардың мотивация деңгейі экспериментке дейін және одан кейін Intrinsic Motivation Inventory сауалнамасы арқылы өлшенді. Нәтижелер эксперименттік топта байқалған ішкі мотивация деңгейінде айтарлықтай айырмашылық болғанын көрсетіп, нөлдік гипотезаны жоққа шығарды. Бұл тұжырымдар орта мектепте геймификация бағдарламалау тілін үйрену контекстінде ішкі мотивацияға үлкен әсер етуі мүмкін екенін көрсетеді.

# Аннотация

Геймификация широко используется во всех сферах, включая образование. Одна из причин повышения мотивации участников. Изучение языка программирования считается сложным как понимание абстрактных понятий, и большинство учителей согласны с тем, что учащимся трудно дается в изучении языков программирования, что приводит к отсутствию мотивации в дальнейшем. Для решения этой проблемы предлагается и исследуется тематическое исследование по геймификации урока информатики для учащихся восьмого класса средней школы, изучающих языков программирования. В двухнедельном эксперименте приняли участие 32 ученика 8-х классов и Codehs, платформа онлайн-обучения использующая геймификацию, была применена к экспериментальной группе, а традиционный метод обучения - к контрольной группе. Уровень мотивации студентов измерялся с помощью опросника Intrinsic Motivation Inventory до и после эксперимента. Выводы свидетельствовали о том, что была существенная разница в уровне внутренней мотивации, наблюдаемая в экспериментальной группе, что отвергает нулевую гипотезу. Эти выводы свидетельствуют о том, что геймификация может иметь большое влияние на внутреннюю мотивацию в контексте изучения языка программирования в младших классах средней школы.

# Abbreviations

IMI	Intrinsic Motivation Inventory
PBL	Points, Badges, and Leaderboards
SDT	Self-Determination Theory
SD	Standard deviation

# Table of Contents

<b>Declaration</b>	<b>i</b>
<b>Acknowledgements</b>	<b>ii</b>
<b>Dedication</b>	<b>iii</b>
<b>Abstract</b>	<b>iv</b>
<b>Аңдатпа</b>	<b>v</b>
<b>Аннотация</b>	<b>vi</b>
<b>List of Abbreviations</b>	<b>vii</b>
<b>1 Background and motivations</b>	<b>1</b>
1.1 Introduction . . . . .	1
1.1.1 Motivation . . . . .	1
1.1.2 Gamification, its origin and concept . . . . .	2
1.1.3 Gamification in Education . . . . .	3
1.1.4 Gamification in Computer Science and Software Engineering	4
1.1.5 Research Question, Hypothesis, Contribution to Gap in Lit- erature . . . . .	6
1.2 Aims and Objectives . . . . .	8
<b>2 Literature Review</b>	<b>9</b>
2.1 Programming learning problems and challenges that novice stu- dents encounter . . . . .	9

2.2	Issues encountered in Implementing Gamification for Teaching and Learning Programming Courses . . . . .	11
2.3	The benefit of implementation of gamification in teaching . . . . .	12
2.4	SDT, Self-Determination Theory . . . . .	14
<b>3</b>	<b>Methodology</b>	<b>16</b>
3.1	Project of the study . . . . .	16
3.2	Partakers . . . . .	17
3.3	Course of the Action . . . . .	18
3.4	Data collection . . . . .	19
3.5	Measurement tools . . . . .	20
3.6	Experiment Conducted for 8th Grade Students to determine the impact and outcome of the gamification. . . . .	21
<b>4</b>	<b>Results</b>	<b>25</b>
4.1	Students' Questionnaire Results Dealing with Gamification in the Context of learning Programming Languages. . . . .	25
4.1.1	Quantitative data analysis. . . . .	26
<b>5</b>	<b>Basic Findings. Limitations. Recommendations.</b>	<b>33</b>
5.1	Basic Findings. . . . .	33
5.2	Limitations and Future work. . . . .	35
5.3	Discussions and Recommendations. . . . .	36
<b>6</b>	<b>Conclusions</b>	<b>39</b>
	<b>Bibliography</b>	<b>41</b>
<b>A</b>	<b>CodeHS gamification platform</b>	<b>45</b>

# Chapter 1

## Background and motivations

### 1.1 Introduction

#### 1.1.1 Motivation

I work in International Secondary school as a Computer Science teacher. One of the subjects that I teach is programming. During my work experience, I have witnessed many students find programming difficult, and thus, their motivation to learn and engagement during the lesson are declined. So, I wondered how to find ways to make it simple and entertaining for students to learn programming languages. Therefore, I related my academic interest in Computer Science education, Gamification and applying gamification in the classroom, both in secondary

challenges sparks rivalry when applied to competitive students, to give a feeling of achievement points and badges are very useful. I am also aware of advantages of gamification, as its influence on students' motivation and engagement, and various gamification strategies that can be employed to occurring challenges.

Furthermore, I have a deep understanding of the specific considerations and best practices for implementing gamification in the context of secondary school and higher education. I can offer guidance on how to design effective gamified learning experiences, align gamification elements with curriculum goals, and address potential cultural or contextual factors that may influence the effectiveness of gamification in different educational settings.

By combining my expertise in gamification and programming language education, I aim to contribute to the field by providing valuable insights, recommendations, and evidence-based practices for educators and researchers interested in incorporating gamification techniques to enhance the teaching and learning of programming languages in secondary school and higher education environments.

### **1.1.2 Gamification, its origin and concept**

Gamification involves putting game elements into non-game situations [1]. The term "gamification" was first used in 2002 by Nick Pelling, and it was formalized in a paper in 2008. It has expanded its application since 2010 across different fields [2]. Instead of a finished product like a serious game, gamification in educational contexts refers to the process of integrating elements from games into non-gaming situations in order to inspire and motivate learners. This strategy aims to have an advantageous effect on learner behavior [3].

Bai et al. (2020) [2] in his meta-analysis work stated that in terms of learning outcomes students who used gamification strategies in their course performed better than their peers who did not. Interestingly that the effect sizes of gamification did not have much difference depending in the student level, the topic area, regardless of tangible rewards included or not in gamification strategy.

Even though many studies proved that gamification as the general trend of being successful strategy, there are still a lot of contradictory findings in the

literature. Koivisto and Hamari conducted 26 studies in total in 2019 and 10 of them had positive results, 9 mixed results and 7 studies with no positive or negative results [4].

Gamification can be applied in different fields, applying elements from games to improve motivation and participation, and also to create experiences that are fun and exciting to motivate and stimulate people. Gamification has built-in qualities that captivate and engage people, such as challenges, feedback or rewards [1].

### 1.1.3 Gamification in Education

Gamification is gaining more attention as one of the pedagogical approaches to develop student's motivation and learning in the context of education. Teachers and educators by presenting gamification elements like badges, levels, quests, leaderboards can design learning environment that is interesting and fun for students. Students who experience gamification, starts to participate actively, receives immediate feedback and promotes behavior to achieve and compete with others [5].

One of the main advantage of gamification in education is that students learn and feel engaged. If students enjoy learning and learns in an interactive way, they will be more motivated and spend more time learning. By arousing psychological needs that are autonomy, competence, and relatedness, gamification can increase the level of intrinsic motivation. It means that students become in control over their studies, they feel that they master when they experience challenges, and collaborative and competitive elements help to feel belonging somewhere.

There are different students with different preferences in studying. Gamification provides with personalized approach in learning when students can choose their own ways of learning, set their own goals, and can see their own progress. In game-based situations students encounter with challenges that promotes skills to solve problems, think critically and creatively.

However, it is important to note that gamification should be implemented thoughtfully and with clear pedagogical goals in mind. Simply adding superficial game elements without meaningful integration or alignment with learning

objectives may not yield the desired outcomes. The design and implementation of gamified elements should be carefully planned, considering factors such as learner preferences, task characteristics, feedback mechanisms, and the balance between extrinsic rewards and intrinsic motivation.

Considering all this, gamification offers a promising approach to enhance engagement, motivation, and learning outcomes in various domains, including education. By leveraging the motivational qualities of games, gamification can create interactive and enjoyable experiences that encourage active participation, foster intrinsic motivation, and promote personalized learning. When implemented effectively, gamification has the potential to transform the learning experience and empower learners to achieve their educational goals.

#### **1.1.4 Gamification in Computer Science and Software Engineering**

Gamification in the field of Computer Science and Software Engineering also can be used as an approach to improve motivation and learning. It helps to simplify complex concepts to make it easy to approach and start to make active contribution in learning to code. Here are some ways gamification is being applied in computer science and software engineering:

1. To practice coding and increase your skills: For novice learners to practice their skills online platforms using gamification elements and mechanics are provided so they can learn in interactive conditions. To compete with others and progress in skills these platforms usually have different elements, such as badges, leaderboards and levels, coding challenges. When learners finish the tasks and challenges, they earn rewards, this makes them stay motivated and focused. The significance of code readability for software quality is discussed in [6], as well as the difficulties computer science students encounter in mastering this capacity. In this study, the researchers introduced an online platform that is called GamiCRS. It uses gamification techniques so their students improve their interest in coding and may engage to learn code readability. Also, the platform provides with all kind of rewards that

facilitates both intrinsic and extrinsic motivators and game-based mechanics is included. According to the findings of the study GamiCRS showed positive impact on learning outcomes. They suggest that gamification is able to enhance the teaching of software engineering classes in a fun and efficient way of learning.

2. Competitions on Coding: Another way of using gamification is in competitions of coding. By collaborating with other participants, it triggers competitiveness in behavior. Hackathons and programming contests, they often offer scoring systems, challenges and time limits, where someone can demonstrate their abilities in coding and skill to solve problems. These can result that participants may feel being succeeded and even lead to innovations.
3. Testing the softwares: Software testing have never been engaging when gamification is employed. Jesus et al. in their systematic mapping (2018) [7], have found three studies for mutation testing education with gamified system design. These studies' main aim was to improve performance of the students and also enhance their level of motivation, interest and engagement. In order to cultivate learning experiences, in addition to PBL triad, they inserted duels and team elements.

Another work by Yujian Fu and Clarke (2016) [8] presented a tool for students that is cyber-enabled and with PBL triad gamification elements for software testing to be fully motivated and engaged. In the system you can find tutorials that are designed for testing different tools and techniques. Yujian Fu and Clarke summarized that there is correlation between students' grades and points, they earned on the gamified tool. It can be accepted as efficient system in education of software testing to foster motivation and also engagement.

The results in computer science and software engineering are very encouraging that it is very important to set clear learning objectives in designing gamification. If gamification was integrated without specific meaning, it may result in confusion or decrease in focus of learning outcomes that was intended. When selecting

feedback mechanisms and gamification elements consideration should be adjusted according to educational principles.

Briefly gamification in computer science and software engineering being used widely to foster motivation, engagement and learning. Gamification stimulates to participate actively, practice coding, participate in contests for coding, team up with peers and experience various topics while learning. If gamification is implemented deliberately, it may foster love for computer science and software engineering and change the way we learn.

### **1.1.5 Research Question, Hypothesis, Contribution to Gap in Literature**

Most students and teachers agree that learning programming language is very difficult as it is hard to understand its abstract ideas and requires ability to solve complex tasks. Students may stop learning because of lack motivation when they have struggles with understanding the programming languages. This lack of motivation poses a significant hurdle to students' progress and can be obstacle in their future success and advancing in the Computer Science field. To deal with this issue, gamification come up as one of the potential solutions to raise students' motivation and engagement in programming language learning.

Research Question:

This study aims to find the answer to the following research question: Does the gamification have impact on the motivation of 8th-grade secondary students during their learning of programming in the classroom?

Hypothesis:

Our hypothesis state there is no increase in the level of motivation of the experimental group versus control group.

Contribution and Gap in Literature:

This study seeks to fill a crucial gap in the existing literature by investigating the impact of gamification on the motivation of 8th-grade lower secondary stu-

dents learning programming languages. The importance of motivation is generally accepted and the challenges, students still face when they study programming, there is a demand in research of focusing on the implementation of gamification to deal with this issue of having motivation in programming, especially considering 8th-grade lower secondary students.

By examining the effects of gamification on intrinsic motivation, this research will contribute to the existing body of knowledge by providing empirical evidence on the effectiveness of gamification in enhancing student motivation in programming language learning.

The obtained findings of this study will clear up the potential benefits and implications of incorporating gamification strategies in the classroom, specifically for 8th-grade lower secondary students. At least some amount of research has been done in other countries till now. However, there is enormous gap in researches in the field of Gamification from Kazakhstan.

The results of this study have the potential to make significant contributions to the field of computer science education, particularly in Kazakhstan. They will provide valuable insights for educators and policymakers, informing instructional practices and curriculum development. By demonstrating the positive impact of gamification on student motivation, this research can offer guidance for educators in designing engaging and effective programming language instruction. Furthermore, the findings can help bridge the existing gap in gamification research in Kazakhstan, laying the groundwork for future studies and advancements in the field.

This study addresses the problem of students' struggle with learning programming languages and the subsequent lack of motivation. By investigating the effect of gamification on the motivation of 8th-grade lower secondary students, this research aims to fill the existing gap in the literature. The results of this study have the potential to contribute to the field of computer science education, providing insights for educators and researchers that intend to apply the gamification methods to teach programming in secondary schools and opening the way for further advancements in programming language instruction and assessment in

Kazakhstan.

## 1.2 Aims and Objectives

Aim:

The aim of this study is to explore the learners' perception of gamification while learning a programming language and identify the effect of gamification on the motivation of 8th-grade learners.

Objectives:

To achieve the aim stated above, the following objectives will be pursued:

1. To investigate the learners' perception of gamification in the context of learning a programming language.
2. To assess the impact of gamification on the intrinsic motivation of 8th-grade learners during the process of learning a programming language.
3. To compare the levels of intrinsic motivation between the experimental group that receives gamified instruction and the control group that follows traditional instructional methods.
4. To provide insights for educators on integrating gamification techniques in programming language instruction to enhance student motivation.

By addressing these objectives, this study will contribute to a deeper understanding of the learners' perception of gamification and its impact on motivation in the context of learning a programming language. The findings will provide valuable insights for educators, helping them make informed decisions about the use of gamification in programming language education for 8th-grade learners.

# Chapter 2

## Literature Review

### 2.1 Programming learning problems and challenges that novice students encounter

When it comes to programming learning problems, Du Boulay (1989) identifies several potential difficulties [9]. These include [10]:

**General Orientation:** This refers to the overall understanding and orientation in program development. It involves the ability to reason about program development and learn from successful programs.

**The Notional Machine:** It refers to the abstract model of the computing process used in program planning. This includes understanding programming languages and code.

**Notation:** This pertains to the programming language used, including its syntax and semantics.

**Structures:** This encompasses the organization and structure of programs, including the planning and development process.

**Pragmatics:** This relates to the practical skills involved in analysis, planning, development, testing, debugging, and other programming-related activities.

Du Boulay (1989) further stresses points that while attempting to address many

problems at once, students frequently run into difficulties when studying computer science, particularly when learning to program. Overgeneralization and improper analogy use may result from this issue. When students make broad conclusions based on their limited programming experience, overgeneralization happens. When programming concepts are represented by incorrect analogies, it can be difficult for others to grasp what is being programmed.

In learning programming, it is crucial for students to develop an early understanding of concepts. This understanding serves as a foundation for acquiring more advanced programming skills. However, a lack of understanding can occur when students simply memorize basic questions or exercises without truly grasping the underlying concepts. Similarly, memorizing programming vocabulary without comprehending its real meaning can impede learning [10].

In work of Singh, T. (2012) [11] General Orientation and Pragmatics also found to be one of many difficulties in learning programming. Baist and Pamungkas (2017) [12] by conducting the survey among 132 students, identified three main difficulties for beginners when study programming: understanding the fundamental concepts of programming structure, designing a program effectively and learning the syntax of a programming language.

Additionally, students often encounter obstacles when learning programming, especially when attempting to complete multiple tasks simultaneously. This can lead to overgeneralization, where students make assumptions based on limited programming experiences. Similarly, misapplication of analogies occurs when students use inaccurate comparisons to understand programming concepts.

It takes active participation in the learning process to overcome these obstacles. Instead than depending on mere memorization, students should work to comprehend programming ideas on a deep level. Promoting critical thinking, problem-solving techniques, and giving students opportunity for practical application are ways that teachers might help with this.

Students can improve their programming abilities and develop a solid foundation in the topic by solving these challenges.

To find solutions around these issues, it's critical that students actively participate in the learning process, seeking a thorough comprehension of programming principles rather than relying just on rote understanding. Teachers should encourage critical thinking, problem-solving, and hands-on practice to enhance students' comprehension and practical skills in programming.

## 2.2 Issues encountered in Implementing Gamification for Teaching and Learning Programming Courses

Issues that students encounter during study of programming course [13, 14, 15] was determined that forced the integration of gamification in these courses, which are categorized as follows [16]:

- Teaching methods: The traditional teaching approach often lacks personalized instruction due to large class sizes, a fixed curriculum, and limited feedback from teachers. These factors hinder the effectiveness of delivering programming concepts to individual students.
- Study methods: Many students lack the necessary background knowledge and experience in programming, resulting in difficulties in problem-solving. Additionally, students may not possess effective study techniques that facilitate their learning in programming courses.
- The nature of programming itself: Programming languages often have complex syntax, requiring students to develop an abstract way of thinking. These cognitive demands can pose challenges for students in grasping and applying programming concepts effectively.
- Psychological and social effects: Students may experience a lack of motivation in learning programming, which can hinder their engagement and overall performance. Anonymity within the classroom environment and a lack of interaction among students may further contribute to decreased motivation and collaboration.

- Academic failure: Some students may struggle to meet the requirements of programming courses, leading to academic failure. This can result in students dropping, failing, or withdrawing from the course, limiting their progress in programming education.

Addressing these issues is crucial in implementing gamification strategies to enhance teaching and learning experiences in programming courses. By understanding and mitigating these challenges, educators can create a more engaging and supportive environment that promotes students' motivation, learning, and success in programming.

## 2.3 The benefit of implementation of gamification in teaching

Gamification, as a method of encouragement and motivation, has proven to be beneficial in various educational contexts, including teaching, learning, and evaluation (De Sousa Borges et al., 2014) [17]. The integration of gamification in learning has been found to be both easy and effective (Al-azawi et al., 2016) [18].

Here are some of the benefits of implementing gamification in teaching and learning, supported by research:

**Increased engagement and motivation:** Gamification increases student engagement and motivation, addressing the intrinsic needs for autonomy, competence, and relatedness. Students are more likely to be actively involved in classroom activities and exhibit a higher level of motivation (Lee and Hammer, 2011) [19].

**Enhanced teamwork and collaboration:** Gamification can be implemented in group learning activities, promoting teamwork and collaboration among students. It encourages them to work together, solve problems collectively, and foster a sense of camaraderie and shared achievement [20].

**Improved learning outcomes:** Gamification has been found to enhance learning and understanding of complex subjects. By integrating game-like elements, such as challenges, levels, and interactive feedback, students are more likely to grasp

and retain knowledge effectively [20].

**Emotional experiences and positive feelings:** Gamification evokes a range of emotions in students, from curiosity to joy and a sense of accomplishment. It creates positive emotional experiences, such as optimism and pride, which contribute to a favorable learning environment (Surendelegh et al., 2014) [21].

**Social interaction and communication:** Gamification encourages social interaction among students through discussions and exploration of concepts. When faced with difficulties, students have meaningful conversations to develop answers, boosting teamwork and communication (Lee and Hammer, 2011) [19].

**Supports individual expression:** According to Lee and Hammer (2011), gamification offers a platform for shy learners to express themselves as well as for everyone in the classroom to publicly recognize their accomplishments and growth [19].

Gamification encourages independent learning, empowering students to take control of their own learning processes. It encourages a sense of self-reliance and responsibility since they are allowed to experiment, study, and explore at their own speed (Pavlus, 2010) [22].

Gamification occurs aside from inside of the classroom to provide flexible learning regardless of it. In their spare time, students can participate in gamified assignments and activities, which offer chances for further learning and engagement with teachers and classmates [22].

**Immediate feedback:** Gamification allows teachers to provide students feedback right away, giving them immediate information on how they are doing and growing. This supports ongoing learning and progress by enabling a deeper comprehension of their advantages and potential improvement areas [23].

In conclusion, gamification may be used to teach and learn programming courses and has several advantages, such as increasing motivation and engagement, encouraging teamwork, and improving learning outcomes. In addition to supporting adapted and individualized instruction, it generates a dynamic and engaging learning environment that encourages good emotional experiences. Additionally,

gamification extends learning beyond the classroom, promotes social interaction, and provides immediate feedback to students, contributing to a more effective and enjoyable learning experience.

## 2.4 SDT, Self-Determination Theory

Students find programming difficult and become demotivated and as a result struggle and under-perform in programming studies [15]. This occurrence could be explained by the Self-Determination Theory [24]. This psychology theory is interpreted as if someone believes their actions makes change, then they tend to be more motivated, and thus have favorable impact on the result they wish.

Based on Deci and Ryan's Self-Determination Theory (SDT) [24], effective gamification involves employing game elements to satisfy three fundamental requirements for intrinsic motivation.

- **Relatedness** is the desire to communicate and relate to others.
- **Competence** is the requirement to solve issues effectively in a certain setting.
- **Autonomy** is the desire to be in charge of one's own life.

Self-Determination Theory (SDT) is the theoretical model that was applied in the most works [25, 26].

The researchers of of this experimental study [27] designed their gamification approach based SDT to determine how gamification affects programming learning and evaluated cognitive, behavioral, and motivational learning outcomes in their analysis. Results indicated that gamification has a positive impact on programming learning through its influence on intrinsic motivation. The effect of gamification on intrinsic motivation shifted over time, beginning as positive and eventually changing to negative when learners had less experience with programming.

In order to motivate computer science students to start and finish programming assignments sooner, this paper [28] develops and evaluates a gamification method

that makes use of software engineering tools. The study suggests that team-based leaderboards with an automated unit testing system, which provides immediate feedback upon task completion, can effectively motivate students by satisfying their needs for autonomy, competence, and relatedness.

# Chapter 3

## Methodology

The previous chapter contains a literature review concerning the study of gamification in different countries. For now it became clear for us the prior studies that already have been done in this area. This section introduces the methodology used to explore how gamification affects students' motivation when they are learning programming languages in the classroom at Galaxy International School, Almaty, Kazakhstan. We carefully chose specific ways to gather and analyze data for this study. By doing this, we aimed to find meaningful insights that can help us understand the topic better. We also want to be honest about the limitations we faced during the study, like things we might have missed or areas that need further investigation. Further, we will provide recommendations for future research in order to make improvements and contribute to the growth of this field of study.

### 3.1 Project of the study

The project of this study adopts a quantitative research paradigm, which focuses on gathering numerical data and operates under the assumption that reality can be measured, tested, and replicated. Quantitative methods emphasize objective measurements and the statistical analysis of data collected through polls, questionnaires, interviews, or existing statistical data using computational techniques.

To address the research objectives and obtain comprehensive answers to the research questions, a case study project with a comparative analysis was chosen within the framework of a quantitative approach. For a more objective observance of the occurrence, quantitative methodology was applied to present understanding in the details of the impact of gamification on students' motivation. The design of the experiment helps to explore the students' involvements with the gamified classroom.

For a more objective observance of the occurrence, quantitative methodology was applied to present understanding in the details of the impact of gamification on students' motivation. The design of the experiment helps to explore the students' involvements with the gamified classroom.

The goal of the researcher is to make contribution to existing literature on gamification in computer science education, specially in the instruction of programming. The results obtained will display effectiveness and employing the gamification as one of the teaching techniques, and inform the potential benefit and challenges they may encounter to those educators who want to apply gamification as the useful tool.

## 3.2 Partakers

32 students of 8th grade from Galaxy International School participated in this study. The implementation of gamification and its elements in the classroom was seen as an innovative approach, particularly in the context of computer science and software engineering education. Teachers recognized the importance of adapting quickly to the changes happening in the educational landscape to nurture young individuals with a global outlook and the necessary skills for future careers in programming.

In this quasi-experimental research, a pre- and post-test questionnaire was administered to assess the impact of gamification on students' motivation in learning programming languages. The study aimed to examine the potential of a gamified classroom in enhancing students' performance and understanding of the subject matter. The sample size included 32 students in total and their average age was

nearly 14 years old. 8 A class was the experimental group, where the gamification was applied to their lesson and 8B was the control group, who studied in traditional method.

Before the experiment, the average score of the gamified group was 71.43, while the average score of the non-gamified group was 70.35. The gamified group comprised 18 students, including 12 girls and 6 boys. On the other hand, the non-gamified group consisted of 14 students, with 8 girls and 6 boys.

By comparing the outcomes between the experimental and control groups, the study aimed to evaluate the effectiveness of gamification in enhancing students' motivation and engagement in learning programming languages. The gender distribution within the groups was also taken into consideration to explore any potential differences in response to gamified instruction.

The participation of these 8th grade students in the study allowed for an examination of the impact of gamification on their motivation levels, providing valuable insights into the potential benefits of integrating gamification into programming language education.

### **3.3 Course of the Action**

Before conducting the research, we got the permission and approval from school principal to ensure authorization of the participant selection and conduct of the experiment. When we first met with the participants, we explained the aim of the study and how it will be carried out, indicating how the procedure will be followed:

For collecting data, both before and after the experiment the participants were asked to fill out the questionnaire. To prevent privacy disclosure and for students' convenience Google forms were sent to each student individually. In order not to interrupt class environment, the questionnaires were delivered in the beginning of the lesson.

To collect the data efficiently, digital format was preferred for storage and thus participants took the questionnaire via computers. Students were informed be-

forehand about the date and time of administering the questionnaire and the experiment. The main goal was to understand participants' perception of gamification during lesson of programming language in the classroom. To establish the accuracy and manage the data easily, responses of all participants were recorded In Google forms.

### 3.4 Data collection

For this study in the process of the collecting the data, we used the questionnaire named as Intrinsic Motivation Inventory (IMI) [29] that developed to assess motivation levels of the participants. We conducted the IMI questionnaire to 8th grade students to obtain information on the participants' motivation when they study the programming language with the special focus gamification effects on their change of motivation.

This IMI inventory is a tool that is regulated to measure various characteristics of intrinsic motivation like enjoyment, interest and perceived competence. We derive deep understanding on how internally people motivated when they are engaged in a specific action or learn something.

By using the IMI questionnaire, the researchers aimed to gather quantitative data on students' motivation levels before and after the implementation of gamification in the programming course. The questionnaire responses were analyzed to evaluate the influence of gamification on students' motivation, allowing the researchers to assess the effectiveness of using gamification as a motivational tool in the learning environment.

The questionnaire included a series of questions aimed at capturing students' perceptions, attitudes, and experiences related to the gamified classroom environment. It focused on aspects such as their level of intrinsic motivation, engagement, interest, and enjoyment in learning programming languages. The questionnaire was carefully constructed to ensure its validity and reliability in measuring the intended variables.

Students were asked to provide their responses based on their personal expe-

periences and feelings before and after the implementation of gamification in the classroom. The questionnaire was administered at the beginning of the experiment and again at the conclusion to capture any changes in motivation over time.

The students were instructed to fill out the questionnaire honestly and to the best of their ability. The data collected from the questionnaire responses would provide valuable insights into the effect of gamification on students' motivation levels during the learning of programming languages.

### 3.5 Measurement tools

In this study, the evaluation measures focused on assessing students' intrinsic motivation using the "Intrinsic Motivation Indicator" (IMI) inventory developed by Ryan and Deci [29]. This inventory has been widely used in laboratory experiments to measure intrinsic motivation in various contexts. The inventory items, which capture different aspects of motivation, were transformed into a questionnaire format and presented to the students.

The questionnaire consisted of 7 statements, and the students were asked to rate their agreement or disagreement with each statement on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). The statements aimed to assess students' enjoyment, fun, interest, attention, and overall perception of the activity related to programming language.

To create a trustworthy atmosphere for the questionnaires, the students were provided with the questionnaires a few minutes before the start of the experiment during the regular classroom lesson. The questionnaires were conducted in English, following the school's educational instruction.

The questions during were designed to gain a deep understanding of the students' motivation specifically related to programming language. The students were encouraged to express their honest opinions and provide detailed responses.

The questionnaire [29] consists of 7 questions:

1. I enjoyed doing this activity very much
2. This activity was fun to do.
3. I thought this was a boring activity.
4. This activity did not hold my attention at all.
5. I would describe this activity as very interesting.
6. I thought this activity was quite enjoyable.
7. While I was doing this activity, I was thinking about how much I enjoyed it.

All 32 students participating in the study answered the same set of 7 questions using Google Forms, an online platform for survey administration. The students' answers were collected, sorted, and analyzed to derive meaningful insights. Additionally, the responses were transcribed to ensure accurate documentation of the students' perspectives.

To analyze and present the study's findings and to fully comprehend the effect of gamification on students' motivation to learn programming languages, the data from the questionnaires served as an important source of data.

### **3.6 Experiment Conducted for 8th Grade Students to determine the impact and outcome of the gamification.**

Conducted experimental study was aimed to explore the impact of gamification on the motivation of 8th grade students who learn programming language in the classroom. The main goal was focused on testing the hypothesis that claims the gamification implementation will not increase students' level of motivation and can not be motivating force for participants further learning. At Galaxy International school located in Almaty the experiment was carried out on the lesson of computer science for two classes of 8th grade, 8A and 8 B.

There were 18 students in 8A class and 14 students in 8B class, with 32 students in total. Diversity of the class has ranged by countries as there were local students from Almaty and international students from other countries like Turkey, India, Moldova. The classroom was equipped with computers for each student and WiFi connection were provided to access the online gamification platform for experimental group for gamified experience.

Evaluating the impact of gamification on students' motivation was the main goal of the study and for its realization we applied quantitative research method. The main data collection tool was IMI questionnaire developed by Ryan and Deci [29] for measuring intrinsic motivation of the participant. We chose this questionnaire for our study because it has been used widely in other experimental works before.

There are 7 statements in the questionnaire with options on 7-point Likert scale, starting with 1 being as strongly disagree to 7 being as strongly agree. The statements formulated such as to grasp students' level of motivation while they were interacting in gamified learning platform. By this questionnaire we can obtain necessary information related to impact of gamification on students' motivation, also offering understanding of their condition within the activity as their enjoyment, boredom and interest.

All necessary permissions and approvals were acquired from the school principal before the conducting the experiment. To establish transparent and trustful environment the goal of the experiment was explained to students and how it is carried out, so the students get acquainted with it. Before and after the experiment the participants were requested to fill out the questionnaire. The questionnaires were taken at the beginning of the lesson, lasting for 2-3 minutes, to provide convenient circumstances to collect the data.

For easy access and convenience, the questionnaires were sent out to every student via Google forms. Following the school's educational instruction language, the questions in the questionnaire were presented in English language. IMI questionnaire were designed in a way to explore the students' motivation in relation with programming. Quantitative data was gathered from the results of students'

responses from questionnaire that would help to provide comprehensive analysis of students' motivation in regards of gamification impact.

Before the experiment the researcher checked carefully different online gamification platforms. Most of the platforms were designed to adults and skills with medium and above and integrated tasks seemed difficult for 8th grade students. Therefore, for this experiment as the gamification platform CodeHS, a web-based platform was chosen (see Appendix A). CodeHS is very well-known platform with many courses of different computer science subjects and topics for every age. There are many interactive lessons, tutorials, quizzes and tasks for problem-solving according to programming language or other computer science related subjects. Along with the study materials various gamification elements such as points, badges, feedback and progress tracking system are integrated in the platform. The researcher particularly selected "Intro to Computer Science in Python 3" course for this experiment, as it contains the list of necessary topics similar with the academic syllabus that 8th grade students need to acquire for fundamental programming skills.

The gamification elements that are integrated in the learning process serves to increase learners' motivation and engagement. In the process of learning on the platform, for completing topic and solving the problem, points and badges are awarded to learners for sense of achievement that also can be shared for view with others. It is available to check how much topics were covered by checking progress bar. The progress bar encourages to continue to learn and engage in the activities by showing the advancement throughout the course. The design and presentation of the course are formed in accordance to students' preferences and interest in a manner to boost favorable behavior to learn programming and gain confidence in coding skills.

The experiment was conducted for 2 weeks during their computer science lessons. There are 2 hours and 40 minutes in total the experimental group was exposed to gamified learning activities. The curriculum was the same for both control and experimental groups with the difference in teaching approach. The experimental group consisted of 18 students experienced gamifying method and the control group consisted of 14 students followed the traditional method. In

the first week topics such as conditionals, comparison and logical operators were covered, in the second week topics related to loops including while loops and for loops are explored. During these two weeks students were given different tasks and challenges to write the code to solve the problems on the lessons.

However, we observed significant difference between these two groups. The control group that experienced the traditional teaching approach, where the topics were explained in a conventional manner. On the contrary the experimental group was involved in a gamified environment, using the CodeHS platform to access to learning materials and experienced different gamification elements which was provided as additional motivation to solve the tasks.

After two weeks at the end of the experiment, both the experimental and control groups have taken the questionnaire again. The obtained quantitative data was sorted, analyzed, and reported. For statistical analysis to produce useful information, responses were recorded and evaluated. The researcher aimed to identify any significant differences in students' motivation between the two approaches by comparing the data from the experimental and control groups.

Through data analysis and questionnaire details we obtained valuable insight on how gamification affects students' motivation. The results of the study made it possible to identify areas for improvement in students' motivation that might be addressed in future lessons. The research also provided suggestions for teachers on the usefulness of gamification as a motivational technique in the context of learning programming languages.

In summary, the experiment with 8th-grade students was to find out how gamification affected student motivation to learn programming languages. The "Intro to Computer Science in Python 3" course and the CodeHS platform [30] presented students to gamification elements including points, badges, and progress tracking. A comprehensive examination of the impact of gamification was possible because to the quantitative data on students' motivation that the questionnaire-based evaluation supplied. The study's conclusions help in understanding the possible advantages and limitations of gamification in programming language learning.

# Chapter 4

## Results

### 4.1 Students' Questionnaire Results Dealing with Gamification in the Context of learning Programming Languages.

In the Section 3.4, of the 3rd Chapter, we mentioned that a questionnaire was administered to 8th-grade students studying Python as part of their Computer Science subject at school. The purpose of the questionnaire was to assess the students' level of motivation affected by the presence of gamification elements in their learning process. The researcher placed significant emphasis on understanding the impact of motivation on students' learning during the data collection phase of the study, drawing from previous research experiences on gamification implementation.

The researcher held the belief that gamification has a positive effect on students' learning, which was supported by existing studies. To investigate this further, an experimental group was taught using gamification techniques, while a control group received instruction in a traditional manner. The data collection employed a quantitative approach, with the questionnaire serving as the primary instrument to gather insights and obtain quantitative data.

The questionnaire consisted of seven questions designed to capture information

about the students' experiences and perceptions regarding the impact of gamification on their learning. These questions likely aimed to assess factors such as motivation, engagement, enjoyment, and perceived effectiveness of gamified learning activities.

#### 4.1.1 Quantitative data analysis.

The obtained quantitative data were carried out through Intrinsic Motivation Inventory (IMI). This inventory measured the students' motivation over a period of two weeks, specifically during the fourth term. The results of the questionnaire were recorded in Tables 4.1-4.4, with each student's responses for the pre-test and post-test for experimental and control groups captured. The columns in the table represent the seven statements from the IMI questionnaire, and the values in each column indicate the scale of agreement or disagreement (ranging from 1 to 7) expressed by the students for each statement.

7 statements from IMI survey [29]:

1. I enjoyed doing programming very much
2. Programming was fun to do.
3. I thought programming was a boring activity.
4. Programming did not hold my attention at all.
5. I would describe programming as very interesting.
6. I thought programming was quite enjoyable.
7. While I was doing programming, I was thinking about how much I enjoyed it.

Table 4.1: Data Collection of pre- test of Control Group

No	Students of 8B	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1	Student 1	5	4	4	5	5	5	4
2	Student 2	7	7	6	7	7	7	7
3	Student 3	3	3	3	5	3	4	3
4	Student 4	4	2	1	6	4	5	2
5	Student 5	4	1	3	4	7	5	4
6	Student 6	5	5	5	6	4	5	4
7	Student 7	3	4	4	3	3	4	2
8	Student 8	4	5	2	3	3	4	5
9	Student 9	7	6	5	6	4	6	4
10	Student 10	7	7	7	7	7	7	7
11	Student 11	5	4	6	6	4	4	2
12	Student 12	4	3	5	4	3	5	4
13	Student 13	5	6	2	4	4	5	5
14	Student 14	5	7	6	7	6	7	5

Table 4.2: Data Collection of pre- test of Experimental Group

No	Students of 8A	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1	Student 1	1	2	2	6	3	2	1
2	Student 2	3	4	3	6	5	5	4
3	Student 3	5	7	5	5	5	7	4
4	Student 5	5	4	6	5	4	5	3
5	Student 5	4	5	6	5	5	4	3
6	Student 6	4	3	3	4	4	3	3
7	Student 7	4	5	5	5	4	5	1
8	Student 8	5	4	7	6	6	5	1
9	Student 9	4	4	4	5	4	5	3
10	Student 10	5	5	5	4	5	5	5
11	Student 11	4	4	5	5	5	5	4
12	Student 12	2	2	4	5	2	2	1
13	Student 13	3	5	4	3	4	4	2
14	Student 14	4	5	6	4	4	5	4
15	Student 15	5	4	4	7	5	6	5
16	Student 16	6	6	4	4	6	4	4
17	Student 17	2	5	2	6	4	3	4
18	Student 18	1	1	3	2	2	2	1

No	Students of 8A	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1	Student 1	1	2	2	6	3	2	1
2	Student 2	3	4	3	6	5	5	4
3	Student 3	5	7	5	5	5	7	4
4	Student 5	5	4	6	5	4	5	3
5	Student 5	4	5	6	5	5	4	3
6	Student 6	4	3	3	4	4	3	3
7	Student 7	4	5	5	5	4	5	1
8	Student 8	5	4	7	6	6	5	1
9	Student 9	4	4	4	5	4	5	3
10	Student 10	5	5	5	4	5	5	5
11	Student 11	4	4	5	5	5	5	4
12	Student 12	2	2	4	5	2	2	1
13	Student 13	3	5	4	3	4	4	2
14	Student 14	4	5	6	4	4	5	4
15	Student 15	5	4	4	7	5	6	5
16	Student 16	6	6	4	4	6	4	4
17	Student 17	2	5	2	6	4	3	4
18	Student 18	1	1	3	2	2	2	1

Table 4.3: Data Collection of post- test of Control Group

No	Students of 8B	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1	Student 1	3	5	3	4	6	4	6
2	Student 2	7	7	7	7	7	7	7
3	Student 3	4	5	4	5	5	5	5
4	Student 4	3	5	4	2	2	4	5
5	Student 5	3	5	6	4	5	6	6
6	Student 6	6	5	4	5	5	3	4
7	Student 7	3	5	5	4	4	5	3
8	Student 8	4	4	2	3	4	3	3
9	Student 9	6	7	5	5	6	7	4
10	Student 10	7	5	3	7	3	7	3
11	Student 11	6	6	4	5	5	6	3
12	Student 12	6	5	4	4	4	3	4
13	Student 13	6	5	2	4	6	6	7
14	Student 14	6	5	5	5	6	6	4

Table 4.4: Data Collection of post- test of Experimental Group

No	Students of 8A	Q1	Q2	Q3	Q4	Q5	Q6	Q7
1	Student 1	3	4	1	1	2	1	1
2	Student 2	6	6	6	5	6	7	6
3	Student 3	7	6	6	6	7	6	7
4	Student 5	6	5	6	6	4	5	6
5	Student 5	5	4	6	6	7	6	6
6	Student 6	5	4	7	6	5	6	7
7	Student 7	4	5	6	6	4	5	5
8	Student 8	6	5	7	7	6	6	7
9	Student 9	4	4	5	5	4	5	4
10	Student 10	7	5	7	7	6	6	7
11	Student 11	5	4	6	6	3	5	6
12	Student 12	3	3	5	5	4	5	6
13	Student 13	6	6	4	5	6	6	4
14	Student 14	5	5	1	4	4	4	4
15	Student 15	4	5	5	7	4	5	3
16	Student 16	6	7	6	6	6	7	7
17	Student 17	3	3	3	4	3	3	3
18	Student 18	1	2	2	2	3	2	1

Table 4.5: Statistical Analysis of Questionnaire Results

	mean		stddev		p-value	
	Exp. Group	Control Group	Exp. Group	Control group	Exp. Group	Control Group
Pre-test	4.08	4.68	1.01	1.24	0.002	0.627
Post-test	4.89	4.80	1.44	0.91		

In Table 4.5, the mean scores, standard deviation, and paired t-test results for the IMI interest/enjoyment subscale of before and after the survey of both the experimental and control groups in the baseline study are presented. This table provides an overview of the students' responses and the statistical analysis conducted to assess the impact of gamification on students' intrinsic motivation in the context of learning programming languages.

The results reveal that the mean scores for the self-report interest/enjoyment subscale were statistically significant for the experimental group ( $p > .05$ ). This indicates that the gamification elements implemented in the experimental group had a notable effect on students' motivation.

The initial hypothesis proposed that there would be no significant difference in intrinsic motivation between the group that underwent gamification and the control group. To test this hypothesis, a t-test was conducted on independent samples to compare the intrinsic motivation of the experimental and control groups.

At the beginning of the experiment, there was no substantial contrast in the intrinsic motivation scores between the gamified group (mean = 4.08, SD = 1.01) and the non-gamified group (mean = 4.68, SD = 1.24). This suggests that initially, both groups had similar levels of intrinsic motivation.

However, at the conclusion of the experiment, there was a significant difference in the intrinsic motivation between the gamified group (mean = 4.89, SD = 1.44) and the non-gamified group (mean = 4.80, SD = 0.91). The p-value for the gamified group was 0.002, indicating a statistically significant difference in intrinsic motivation. For the non-gamified group, the p-value was 0.627, suggesting no

significant difference in intrinsic motivation.

Based on these outcomes, it can be concluded that there was a significant difference in intrinsic motivation between the two groups. The implementation of gamification elements in the experimental group positively influenced students' intrinsic motivation. As a result, the null hypothesis, which stated no difference in intrinsic motivation, was rejected.

These findings support the belief that gamification can be an effective approach to enhance students' motivation in the context of learning programming languages. The use of gamification elements in educational settings has the potential to engage and motivate students, ultimately leading to improved learning outcomes.

# Chapter 5

## Basic Findings. Limitations. Recommendations.

### 5.1 Basic Findings.

This chapter sums up the research findings, considers the limitations, represents the study recommendations and summarizes the research work. The research findings based on the aim of the study are given below.

**Students' motivation during implementation of gamification in the learning of programming language.** The results of the questionnaire show that gamification has a positive effect on increasing students' motivation and interest in learning which contributes to further learning, rather than traditional approach.

**Quantitative data in action research.** In the action research, quantitative data was collected through classes and questionnaire operated among 8th grade students using both gamification and a traditional approach. The research took place during the 4th term of the 2022-2023 academic year, specifically in classes 8A and 8B. A total of 32 students participated in the experiment, with 18 students in Class 8A and 14 students in Class 8B.

The researcher followed the same curriculum for both the control group (which

used the traditional approach) and the experimental group (which incorporated gamification) over a period of two weeks. The objective was to examine the impact and outcomes of gamification on students' motivation in learning programming languages.

The results obtained from the questionnaire, which was administered both with and without the use of gamification, indicated a significant positive effect of gamification in the classroom. When analyzing the p-value scores of the experimental and control groups, as shown in Tables 4.5, it was observed that the level of student motivation in the gamified group increased notably. Specifically, the mean scores for intrinsic motivation differed significantly from those of the control group, and the p-value was greater than 0.05.

These findings suggest that the implementation of gamification had a positive influence on students' motivation in learning programming languages. The results indicate that gamification can be an effective strategy for enhancing student engagement and motivation, as reflected in the increased intrinsic motivation scores.

This chapter sums up the research findings, considers the limitations, represents the study recommendations and summarizes the research work. The research findings based on the aim of the study are given below.

**Students' motivation during implementation of gamification in the learning of programming language.** The results of the questionnaire show that gamification has a positive effect on increasing students' motivation and interest in learning which contributes to further learning, rather than traditional approach.

**Quantitative data in action research.** In the action research, quantitative data was collected through classes and questionnaire operated among 8th grade students using both gamification and a traditional approach. During the 4th term of the 2022-2023 school year, we conducted an experiment for classes 8A and 8B. There are 32 students that took part in our experiment in total, from 8A class 18 students and from 8B 14 students.

The control group, where students studied in the traditional way and the ex-

perimental group, where gamification was incorporated in the classroom, both followed the same curriculum during of two weeks. The objective was to examine the impact and outcomes of gamification on students' motivation in learning programming languages.

We administered the questionnaire to both groups and from obtained quantitative results, found out that gamification had positive influence on motivation of experimental students. If we look at the results shown in Table 4.5, we can clearly see the difference in p-value scores of experimental group and control group, where amount of increase in the level of motivation of gamified group is certain. We understand the difference in mean scores for intrinsic motivation of experimental group from control group is p-value being less than cut-off value 0.05.

Based on the obtained findings we may suggest that integration of gamification in the classroom for learning programming have positive influence on students' motivation. The results indicate that gamification can be an effective strategy for enhancing student engagement and motivation, as reflected in the increased intrinsic motivation scores.

## 5.2 Limitations and Future work.

We need to accept that our study has several limitations. One of them is small-scale of sample size participated in our study, consisting of only 32 8th grade students. It is hard to generalize our findings to a larger group because of bounded number of students. We recommend to reproduce the study with broader and various sample to improve accuracy of our results.

Another one is the duration of the experiment that only lasted for two weeks, is considered comparably short. This prevents from assuming how gamification would have affected on students' motivation and interest in learning on the long-term. Extending the duration of the intervention could provide a more comprehensive understanding of the sustained impact of gamification on students' motivation.

Additionally, the study encountered technical problems, particularly related to

the loading speed of necessary materials on the platform. These technical issues could have potentially affected the students' experience and engagement with the gamification elements. It is important to address such technical challenges in future implementations to ensure a smooth and uninterrupted learning experience for the students.

Considering these limitations, future research could aim to address these issues by employing larger sample sizes, conducting longer interventions, and ensuring the smooth functioning of technological aspects. By doing so, researchers can enhance the robustness and generalizability of the findings, providing a more comprehensive understanding of the impact of gamification on student motivation and learning outcomes in programming language education.

### 5.3 Discussions and Recommendations.

In recent years, there has been a limited amount of research conducted in the field of gamification within computer science. However, a few review papers have emerged since 2018, specifically focusing on the gamification of programming courses at the higher education level. One particularly notable state-of-the-art paper, authored by Marisa Venter (2020) and referred to as [31], endeavors to address this research gap by providing an extensive literature review. This review specifically examines studies conducted between 2014 and 2019 that explore the utilization of gamification techniques in programming instruction within higher education. A total of 21 papers were included and analyzed within this study.

Furthermore, in a literature review paper [26] that investigates the gamification of teaching programming languages in higher education to enhance student engagement and motivation, 13 papers from various countries including Malaysia, Spain, Brazil, Singapore, Indonesia, and Colombia were examined.

Gamification is gaining attention internationally more often, but still new field in Kazakhstan, that do not have much study in the field of Computer Science. Therefore, this work has been initiated with the goal to explore the employment of gamification in Computer Science education in Kazakhstan and thus, to contribute to existing literature. Conducting this research will help us to obtain more

deep understanding of gamification's potential in the field of Computer Science education and to reduce the gap in existing literature.

As mentioned above the main aim that we set is to find out how gamification may influence on 8th grade students' motivation when they learn programming languages. Quantitative analysis was done by obtaining results from IMI questionnaire to determine if gamification will change the level of students' motivation and interest in programming. In findings achieved by Facey- Shaw et al. (2019) [32], states that gamification elements do not have impact on intrinsic motivation of students of introductory programming class, whereas we got opposed results proving that students' motivation and interest in learning programming increased positively. The questionnaire data showed that the mean scores for intrinsic motivation were significantly higher in the gamified group compared to the control group. This suggests that the incorporation of gamification elements in the classroom environment can enhance students' engagement and motivation, leading to improved learning outcomes. Furthermore, the traditional methods of learning tend to be less interactive and practical, especially in the context of introductory programming courses. Tasadduk et al. (2020) [33] identified a major challenge: students with traditional rote learning backgrounds face difficulties when pursuing higher education in computer programming. The explanation to this can be that to solve programming tasks requires critical thinking skills and ability to solve the given problem. However, to solve this issue the use of gamification techniques can provide with more interesting and fun to learn environment. By leveraging game elements, teachers can create a motivating and supportive environment that encourages students to persist through temporary difficulties and develop a sense of autonomy and confidence in their learning journey starting from secondary school. By incorporating gamification elements into the programming course, teachers aimed to address the difficulties faced by students and create a more engaging and motivating learning environment. Gamification offers interactive and practical approaches that can help students overcome the complexities of programming. It provides opportunities for students to actively participate, explore, and practice their coding skills in a gamified context.

The introduction of gamification as a strategy aims to boost students' learning

outcomes and maintain their motivation throughout the course. It offers a fresh approach that encourages students to overcome temporary difficulties by creating a sense of interest, challenge, and achievement. Gamification gives opportunity for teachers to produce an environment to learn, where student can feel confident in themselves and motivated to find solutions to programming tasks.

In summary traditional teaching method for learning programming language need to be substituted partially with contemporary strategies and techniques like gamification that are effective to improve students' learning and motivation. Gamification emerged as a promising solution that can provide a more interactive and practical learning experience, helping students overcome the difficulties associated with programming and fostering their sustained engagement and motivation.

# Chapter 6

## Conclusions

The objective of this research was to examine the impact of gamification on the intrinsic motivation of 8th grade students studying programming languages. The research employed both methodological and empirical approaches, with quantitative data collected through an experiment conducted with the participation of the teacher and 32 students from grades 8A and 8B. The experiment involved two groups: an experimental group that used the CodeHS platform with gamification elements and a control group that followed a traditional teaching method. The students' performance in learning topics such as Conditionals and Loops was assessed over a two-week period. The study analyzed the results of an IMI questionnaire administered before and after the experiment to evaluate the effects of gamification on motivation.

Based on the questionnaire responses, it was concluded that gamification enhances students' motivation in learning programming languages. The quantitative data supported this conclusion, showing a significant positive effect of gamification in the classroom. During the analysis, the p-value score of the experimental group was 0.002 and the p-value score of the control group was 0.627, meaning the level of students' motivation in the gamified group increased, but no difference in non-gamified group. The p-value for experimental group being less than 0.05 proves it specifically.

that implementing gamification strategy in learning programming language can improve students' intrinsic motivation remarkably. These findings suggest that gamification can address the limitations of traditional teaching methods, which tend to be less interactive and practical in the programming classroom.

However, the limitations that exist in this study, such as limited sample size, short duration of the experiment, and also technical issues that students encountered during the use of gamified platform, are all should be addressed. We may assume that these limitations can influence the findings' generalizability and efficacy of gamification approach. We recommend for future works to conduct studies on larger population , for an extensive period and to make sure technical problems are resolved to address these limitations.

The findings of this study have many potential consequences for teaching and learning. Educators should consider integrating gamification elements into their programming language courses to enhance student motivation. By creating a gamified learning environment, teachers can promote active participation, exploration, and practice, thus helping students overcome the difficulties associated with learning programming languages. Also, it is very important to take into account issues that can occur on online platform or unstable WiFi connection that may prevent from smooth implementation of gamification in the classroom.

To have deep understanding, further research is recommended to explore different gamification techniques and their potential impact on student motivation and learning outcomes in programming education. For example, considering qualitative research methods and taking interviews and feedbacks from learners and teachers, implementing specific gamification elements to observe its affect on students' learning outcome or perceptions of gamification in programming language in other themes.

# Bibliography

- [1] Sebastian Deterding, Dan Dixon, Rilla Khaled, and Lennart Nacke. From game design elements to gamefulness: defining "gamification". In Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments, pages 9–15, 2011.
- [2] Shurui Bai, Khe Foon Hew, and Biyun Huang. Does gamification improve student learning outcome? evidence from a meta-analysis and synthesis of qualitative data in educational contexts. *Educational Research Review*, 30: 100322, 2020.
- [3] Katrin Becker. What's the difference between gamification, serious games, educational games, and game-based learning. *Acad. Lett*, 209:1–4, 2021.
- [4] Jonna Koivisto and Juho Hamari. The rise of motivational information systems: A review of gamification research. *International Journal of Information Management*, 45:191–210, 2019.
- [5] Juho Hamari, Jonna Koivisto, and Harri Sarsa. Does gamification work?—a literature review of empirical studies on gamification. In 2014 47th Hawaii international conference on system sciences, pages 3025–3034. Ieee, 2014.
- [6] Qing Mi, Jacky Keung, Xiupei Mei, Yan Xiao, and W. K. Chan. A gamification technique for motivating students to learn code readability in software engineering. In 2018 International Symposium on Educational Technology (ISET), pages 250–254, 2018. doi: 10.1109/ISET.2018.00062.
- [7] Gabriela Martins de Jesus, Fabiano Cutigi Ferrari, Daniel de Paula Porto, and Sandra Camargo Pinto Ferraz Fabbri. Gamification in software testing:

- A characterization study. In Proceedings of the III Brazilian Symposium on Systematic and Automated Software Testing, pages 39–48, 2018.
- [8] Yujian Fu P.E. and Peter J. Clarke. Gamification-based cyber-enabled learning environment of software testing. In "2016 ASEE Annual Conference & Exposition", number 10.18260/p.27000, New Orleans, Louisiana, June 2016. ASEE Conferences. <https://peer.asee.org/27000>.
- [9] Matt Bower and Katrina Falkner. Computational thinking, the notional machine, pre-service teachers, and research opportunities. *ACE*, 160:37–46, 2015.
- [10] HW Prabawa, H Sutarno, J Kusnendar, and F Rahmah. Learning basic programming using clis through gamification. In *Journal of Physics: Conference Series*, volume 1013, page 012099. IOP Publishing, 2018.
- [11] Tejinder Singh. New learning methodology for student of java programming.
- [12] Abdul Baist and Aan Subhan Pamungkas. Analysis of student difficulties in computer programming. *Volt: Jurnal Ilmiah Pendidikan Teknik Elektro*, 2: 81–92, 2017.
- [13] Essi Lahtinen, Kirsti Ala-Mutka, and Hannu-Matti Järvinen. A study of the difficulties of novice programmers. *Acm sigcse bulletin*, 37(3):14–18, 2005.
- [14] Iain Milne and Glenn Rowe. Difficulties in learning and teaching programming—views of students and tutors. *Education and Information technologies*, 7:55–66, 2002.
- [15] IT Chan Mow. Issues and difficulties in teaching novice computer programming. In *Innovative techniques in instruction technology, e-learning, e-assessment, and education*, pages 199–204. Springer Netherlands, 2008.
- [16] Julian Moreno and Andres F Pineda. Competitive programming and gamification as strategy to engage students in computer science courses. *Revista ESPACIOS*, 39(35), 2018.
- [17] Simone de Sousa Borges, Vinicius HS Durelli, Helena Macedo Reis, and Seiji Isotani. A systematic mapping on gamification applied to education. In *Pro-*

ceedings of the 29th annual ACM symposium on applied computing, pages 216–222, 2014.

- [18] Rula Al-Azawi, Mohaned Al-Obaidy, Aladdin Ayesh, and Duska Rosenberg. The impact of using educational gamification in mobile computing course: A case study. In *Communication, Management and Information Technology*, pages 249–254. CRC Press, 2016.
- [19] Joey J Lee and Jessica Hammer. Gamification in education: What, how, why bother? *Academic exchange quarterly*, 15(2):146, 2011.
- [20] Jaouja Maiga and Andi Wahju Rahardjo Emanuel. Gamification for teaching and learning java programming for beginner students-a review. *J. Comput.*, 14(9):590–595, 2019.
- [21] Garamkhand Surendeleg, Violet Murwa, Han-Kyung Yun, and Yoon Sang Kim. The role of gamification in education—a literature review. *Contemporary Engineering Sciences*, 7(29):1609–1616, 2014.
- [22] Rania Elshiekh and Laurie Butgerit. Using gamification to teach students programming concepts. *Open Access Library Journal*, 4(8):1–7, 2017.
- [23] Iulian Furdu, Cosmin Tomozei, and Utku Kose. Pros and cons gamification and gaming in classroom. *arXiv preprint arXiv:1708.09337*, 2017.
- [24] Edward L Deci and Richard M Ryan. The " what " and " why " of goal pursuits: Human needs and the self-determination of behavior. *Psychological inquiry*, 11(4):227–268, 2000.
- [25] Katie Seaborn and Deborah I Fels. Gamification in theory and action: A survey. *International Journal of human-computer studies*, 74:14–31, 2015.
- [26] Lazzat Tolegen and Akerke Alseitova. What forces us to gamify the programming in higher education: A literature review. In *2023 17th International Conference on Electronics Computer and Computation (ICECCO)*, pages 1–4, 2023. doi: 10.1109/ICECCO58239.2023.10146601.
- [27] Luiz Rodrigues, Armando M Toda, Wilk Oliveira, Paula T Palomino, Anderson Paulo Avila-Santos, and Seiji Isotani. Gamification works, but how

and to whom? an experimental study in the context of programming lessons. In Proceedings of the 52nd ACM technical symposium on computer science education, pages 184–190, 2021.

- [28] Madison W Call, Erik Fox, and Gina Sprint. Gamifying software engineering tools to motivate computer science students to start and finish programming assignments earlier. *IEEE Transactions on Education*, 64(4):423–431, 2021.
- [29] Edward L Deci and Richard M Ryan. Intrinsic motivation inventory. 2000. <https://selfdeterminationtheory.org/intrinsic-motivation-inventory/>.
- [30] URL <https://codehs.com/>.
- [31] Marisa Venter. Gamification in stem programming courses: State of the art. In 2020 IEEE global engineering education conference (EDUCON), pages 859–866. IEEE, 2020.
- [32] Lisa Facey-Shaw, Marcus Specht, Peter van Rosmalen, and Jeanette Bartley-Bryan. Do badges affect intrinsic motivation in introductory programming students? *Simulation & Gaming*, 51(1):33–54, 2020.
- [33] Mamoona Tasadduq, M Salman Khan, Rao MA Nawab, M Hassan Jamal, and M Tayyab Chaudhry. Exploring the effects of gamification on students with rote learning background while learning computer programming. *Computer Applications in Engineering Education*, 29(6):1871–1891, 2021.

# Appendix A

## CodeHS gamification platform

