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**Identification and Implementation of Gamification Elements for Improvement of
Efficiency and Quality of Education in IT programming sphere, a Systematic
Literature Review.**

**Thesis submitted for
the degree of Bachelor in
6B04110 IT in Business**

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Astana, 2025

Abstract

This thesis paper explores the development of a web-based interactive coding platform and implementation of gamification elements to it as means of improving educational efficiency and educational value provided by it in programming education. The objective was twofold: first, to investigate which gamification strategies are most effective in improving learner motivation, engagement, and performance through a systematic literature review (SLR); and second, to apply these insights in the development of a practical, gamified educational tool tailored for higher education contexts, particularly within Kazakhstan.

The Systematic Literature Review analysed findings from 20 peer-reviewed studies published in recent years on the topic of gamification in programming education. The review identified most commonly used gamification elements such as points, badges, and leaderboards and evaluated their individual and combined effects on educational outcomes. Findings indicate that while no single gamification element is universally effective, thoughtful combinations of elements aligned with pedagogical goals significantly improve learner engagement and academic performance.

The gained insights were then used for creation of a web-based coding platform which features a built-in code editor and a gamified library of solvable programming challenges. The platform implements such gamification elements as experience points, levels, achievement badges as well as some time tracking elements to reinforce user motivation and provide increased engagement.

This study demonstrates the potential of research-informed gamification design in creating effective educational tools. The project also contributes a regionally relevant prototype that addresses a gap in the Kazakhstani market for accessible, interactive, and engaging programming education platforms. Limitations and directions for future research and development are discussed.

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Introduction

Rationale

Programming education has seen substantial innovation in recent decades. However, there are still challenges that exist, particularly with how students engage with and retain programming knowledge, especially in traditional education that prioritize theoretical instruction over interactive, practical and more hands-on learning. These conventional approaches can limit student motivation, lead to reduced lesson engagement and slow down the learning progress.

Gamification - the use of game-like elements such as points, leaderboards, levels, badges and etc. in non-game contexts, can be used as a promising strategy to improve the educational outcomes. In the context of programming education, gamification can have great effect on students' motivation and academic achievement (Zhan, Z. et al., 2022), by providing timely feedback, encouraging consistent practice, rewarding progress and providing a sense of achievement.

Several online platforms such as LeetCode and W3Schools have implemented basic gamification features. These platforms may offer challenges, track user progress, or display leaderboards. However, implementations vary widely, and there is no universally accepted framework that guides educators on which gamification elements are most effective for programming education. Moreover, these tools often lack integration with formal pedagogical structures and are not necessarily tailored for use in academic institutions.

Although numerous studies and frameworks advocate for gamification in education, and while the overall perception of its effectiveness is largely positive, there is still limited clarity on what are the best design approaches and which specific gamification elements are most effective, and how they affect learning outcomes in programming. The lack of consensus makes it difficult to design well-balanced, evidence-based gamified platforms for programming instruction.

As such, the Systematic Literature Review (SLR), which is a structured method for identifying, analysing, and synthesizing existing research, was chosen as the study's research approach. SLRs are commonly used in educational research to identify trends, evaluate findings, and provide a broader perspective on a given topic. The main reason for choosing this approach is that I hypothesize that since the COVID-19 pandemic there was shift in global trends more towards online education and as a by-product of that – to more gamification. The idea is that there should've been more comprehensive research done in the field of gamification in programming education since that time and conducting a

review of existing literature allows for a comparative analysis of these different studies and identification of the most useful trends and elements as well as research gaps and spaces for further research.

While some prior reviews have examined gamification in general education or computer science, there remains a need for an up-to-date synthesis focused specifically on programming education, grounded in empirical research. This review aims to bridge that gap by identifying and analysing the most recent studies and highlighting the most effective trends and approaches, to help with the development of my gamified educational platform.

Objectives

The primary objective of this systematic literature review is to identify the most common and effective gamification elements and approaches in the context of programming education. This study aims to:

- **Review and synthesize existing empirical research** to determine which gamification elements (e.g., badges, leaderboards, experience points) have the most positive impact on learner engagement, motivation, and performance in programming education;
- **Support the design and development** of a gamified, web-based coding platform for students, grounded in the findings of the review.

Research Questions

Using the PICO framework, the following main research question has been conceived:

Among undergraduate students and/or self-learners can adding Gamification elements to the learning process lead to positive outcomes?

- **Population:** University students or self-learners engaged in programming courses.
- **Intervention:** Gamification elements (points, badges, leaderboards, etc.).
- **Comparator:** Non-gamified or traditionally taught programming education.
- **Outcome:** Improved student engagement, motivation, and academic performance, etc.

The study also aims to answer some additional sub-questions related to the main question, that should further expand the topic and provide some better insights:

1. Which gamification techniques (e.g., leaderboards, badges, XP, storytelling) are most commonly used in programming education?
2. How do gamification elements affect student engagement, motivation, and learning outcomes?
3. What are the challenges and limitations of gamifying programming education?

Methodology

This study roughly followed PRISMA 2020 guidelines, as well as “Guidelines for performing systematic literature reviews in software engineering.” (Kitchenham & Charters, 2007)

Inclusion and Exclusion criteria

The following inclusion and exclusion criteria have been chosen for the Systematic Literature Review:

Keep papers that:

- Are relevant to gamification in coding/programming education (not just general gamification).
- Are empirical studies
- Were published no later than 2021
- Are above K-12 level (studies conducted on university undergraduate students)

Exclude papers that:

- Are not freely accessible (not open-access)
- Are not in English

The focus on empirical studies was chosen so that valid research data could be analysed and conclusions could be drawn. As mentioned previously, the particular time period of after 2021 for the research papers was chosen due to the fact that there was a major push for online and virtual education in 2020 due to the COVID pandemic and the expectation is that noticeable progress should've been made by the year 2021 and that in the pandemic timeframe there would likely be tangible developments made in the sphere of gamification and online education.

Searching Methods.

The search was conducted using the Google Scholar (<https://scholar.google.com/>), IEEE Xplore (<https://ieeexplore.ieee.org/Xplore/home.jsp>) and ERIC (<https://eric.ed.gov/?>) databases, using keywords: “Gamification in programming education”, “Gamification for coding education”.

Having applied the “Since 2021” and “Sort by relevance” filters, after searching through 50 pages of Google Scholar during the last few days of March, I have managed to identify 12 studies that had fit the inclusion and exclusion criteria. Initially I stopped there, since around the page 35 of Google Scholar, there were basically no relevant studies all the way up to page 50. Though after having a consultation meeting, I decided to be more thorough and afterwards, at 21nd of April, I have looked through Google Scholar again up to the 100th page to identify potentially missed relevant research papers and indeed, I have managed to identify 4 papers that fit my inclusion and exclusion criteria. However, as I was reviewing previously found research, I’ve found that one of the original 12 papers, which was previously in open-access has become subscription-only, as such, it was excluded. Moreover, after careful reviewing, two research papers were excluded, one because it didn’t provide any relevant results to my research and another because it didn’t provide any information on gamification elements used.

For IEEE Xplore, which I accessed on 20th of April, I used the “Open Access Only” filter and set the range from 2021 to 2025 while searching for the aforementioned keyword. The resulting search had only yielded 11 results, 4 of which were initially included but after careful reviewing, one of the four papers was excluded due to the lack of relevant outcome information.

For ERIC database which I accessed on 20th of April as well, I used “Programming” as Descriptor filter, set the Publication Date since 2021 (pubyearmin: 2021), checked the “Full text available on ERIC” box as well as “Peer reviewed only” box. The following search resulted in 117 results, 5 of were picked as valid.

No automation tools were used in this process, and all paper selection, reading, and data extraction were performed manually. Each selected paper was carefully examined using a consistent, multi-stage filtering process. Initially, the title and abstract were reviewed to assess relevance to the topic of gamification in programming education. If the abstract lacked sufficient detail, the methodology and results sections were consulted to determine the type of study (empirical or not), the participant demographics (ensuring above K–12 level), and what particular gamification techniques and elements were studied.

Papers that lacked clarity in their design or participant population - if a study did not clearly indicate that participants were university students or if it did not explicitly report gamification elements in programming contexts - then it was excluded from the review.

Data Extraction.

The primary outcomes for which data were sought were aligned with the PICO-based research question and included the following domains:

- **Student engagement** (e.g., frequency of participation, course completion rates, active involvement in learning activities)
- **Student motivation** (e.g., self-reported motivation, intrinsic/extrinsic interest, enthusiasm for programming)
- **Academic performance** (e.g., grades, final scores, task completion rates)

During the data collection phase, I initially hoped to find more clear quantitative data, but during the screening process, it became apparent that significant portion of the studies did not include direct numeric comparisons (e.g., "performance improved by X%") and instead focused on subjective indicators (e.g., students *felt* more motivated), I decided to include both types of findings, both quantitative (numerical, statistical measures) and qualitative (descriptive, perception-based).

Quality assessment.

To assess the quality of any given study, I decided to create and use a simple quality assessment checklist, using Kitchenham & Charters, 2007, as well as CASP checklist as a guide. Due to time and resource constraints, I settled on choosing six questions, which I thought would be most relevant.

Quick Quality Assessment Checklist (Score 0–2 per item):

Q1. Are the aims clearly stated?

Q2. Are the measures used in the study the most relevant ones for answering the research questions?

Q3. Was the sample size justified?

Q4. Is there a comparison or control group?

Q5. Do the researchers explain the consequences of any problems with the validity/reliability of their measures?

Q6. Are the main findings clearly defined?

Based on the points gained from answering these questions, each study was rated as “High quality” (12-9) points, “Moderate quality” (8-6) and “Low quality” (5-0).

After the quality assessment, 12 out of 20 studies were deemed “High quality”, 4 out of 20 “Moderate quality” and the remaining 4 as “Low quality”.

Num	Authors	Q1	Q2	Q3	Q4	Q5	Q6	Total
2	Imran H., 2022*	2	2	2	2	2	2	12
10	Jusas et al, 2022	2	2	2	2	2	2	12
11	Cigdem et al, 2023*	2	2	2	2	2	2	12
6	Huesca et al., 2023	2	2	2	2	2	2	11
12	García-Iruela et al, 2022	1	2	2	2	2	2	11
5	Cuervo-Cely et al, 2022	2	2	1	2	1	2	10
9	Palaniappan & Noor, 2022	2	2	2	0	2	2	10
15	De Santo et al, 2022	2	2	2	0	2	2	10
16	Kilic, 2022	1	1	2	2	2	2	10
17	Dahri et al, 2025	2	2	2	0	2	2	10
19	Garcia et al, 2023	2	1	1	2	2	2	10
18	Fidan & Sengel, 2022	1	2	2	0	2	2	9
13	Xinogalos & Satratzemi, 2022	2	2	1	0	1	2	8
14	Trinidad et al, 2021	1	1	2	0	2	2	8
4	Pratama et al., 2021	1	1	2	2	0	1	7
20	Yesengazyevna et al, 2022	2	2	1	0	0	2	7
3	Cao C., 2023	2	1	1	0	0	1	5
7	Pinto, M., & Terroso, T, 2022	1	1	1	0	1	1	5
1	Ouahbi et al., 2021	1	1	1	0	0	1	4
8	Christopher & Waworuntu, 2021	1	1	1	0	0	1	4

Figure 1.

See appendices for the EXCEL document.

Synthesis Approach

Given the diversity of outcomes and study formats, meta-analysis wouldn't be feasible to conduct, as such, I decided to settle on a narrative synthesis Ryan R. (2013), aiming to summarize the findings of each included study and find similar trends among them.

Results and Analysis

This synthesis integrates findings from 20 studies to address the impact of gamification on programming education. While the primary focus is on studies comparing gamified and non-gamified approaches (PICO framework), broader insights from non-PICO studies have also been included to provide better insights, as there isn't much research done on this particular topic. The synthesis is organized thematically around the research questions, combining quantitative outcomes and qualitative perceptions to provide a holistic perspective. Out of 20 studies, only 10 of them are PICO-aligned (have quantitative data and comparator/control group), the rest do not have defined control groups and either

used pre and post tests to determine the effectiveness of approach or just utilized surveys to gather qualitative data.

Answering the Research Questions

Among undergraduate students and/or self-learners can adding Gamification elements to the learning process lead to positive outcomes?

The majority of PICO aligned studies (7/10) reported positive outcomes, though the remaining three reported that introduction of gamification had little to no significant statistical effect. Concerning the non-PICO aligned research, the overall sentiment is positive towards gamification, all of the studies report positive findings and positive perceptions towards gamification. The following section will summarize the findings of the included studies, aiming to provide a comprehensive overview of the gathered research, presenting them as is and not focusing on any particular outcomes or categorizing them just yet. Later sections will go more in-depth on gamification elements used in each study and their effects on motivation, engagement and academic performance.

Starting with the research that is considered most reliable – studies which used Randomized Controlled Trial as their study design. (Griffiths, A. 2021), (George Washington University, 2023). Imran (2022) and Garcia et al. (2023) studies used RCT as their study design, their findings both reveal positive relationship between gamification and academic performance and engagement. Experimental groups in both studies had around 15-20% better academic metrics than their respective control groups. Imran's research in particular, with the sample size of 450 and utilization of two experimental groups (High Gamification and Low Gamification, provides a lot of valuable insights for effects of gamification and particular gamification elements on education in programming education. The study reports increased student motivation, engagement and academic performance in experimental group, particularly in High Gamification group, indicating effectiveness of intervention. Though researcher also notes, that after adjusting for confounders, engagement gains were not deemed statistically significant unlike motivation and performance gains. Regarding Garcia et al.'s research, it should be noted, that gamification wasn't the sole method of intervention, flipped learning and serious games were also used alongside gamification elements. Nevertheless, both of these studies make strong argument for effectiveness of gamification in programming education.

Moving onto Quasi-experimental studies, there are a total of seven of them, 6 are PICO-aligned: Kilic (2022), Cuervo-Cely et al, (2022), Huesca et al., (2023), Jusas et al, (2022), Cigdem et al, (2023), García-Iruela et al, (2022) and Ouahbi et al., (2021). Starting with the studies that have clear experimental quantitative data, Huesca's study, which had three experimental groups: gamification only group, gamification and flipped learning group and flipped learning only group; reports that there is

statistically significant 9% learning gain for gamification only group, similar 9% gains were observed for flipped only group, though for gamification and flipped learning combination group, there was no significant difference when compared to the control group. These findings actually support Garcia et al. (2023) research, which also used flipped learning and gamification. Garcia et al.'s research is divided into three teaching modules and each module focused on a different approach. Together, both these studies suggest that gamification and flipped learning have positive effects on learning gains. However, as Huesca notes, combination of both these strategies at the same time likely leads to too much complexity, which negates positive effects of each individual approach and leads to negative learning gains, when compared to them.

Jusas et al. (2022), Cigdem et al. (2023) and García-Iruela et al. (2022) studies provide rather mixed research outcomes. Garcia-Iruela et al. (2022) reports no significant difference between gamified and control group in motivation, satisfaction and engagement. Cigdem et al. (2023) reports no significant differences were found between the experimental group and control group on theoretical exam, practice exam and midterm exam. Neither were any significant difference found between two groups when it came to motivation and engagement, though during the first three weeks of the experiment, experimental group has completed more quizzes than the control group, indicating initial high engagement and motivation but afterwards the results levelled off and became similar to the control group. However, this study only used one gamification element – leaderboards. Authors note, that leaderboards alone are not likely enough to significantly improve academic performance, engagement and motivation. Jusas et al. (2022) reports statically insignificant increase in mean grades, compared to previous non-gamified study years, however, they also note, that gamification has seemingly reduced number of course retakes and second final exam attempts. Moreover, the study reports notably increased engagement and motivation thanks to the global teams gamification element.

Next, Cuervo-Cely et al. (2022) and Kilic (2022) studies provide some interesting quantitative and qualitative insights. Cuervo-Cely et al. findings show that introduction of gamification elements to the experimental group increased the group's task valuation – students reported increase in perceived usefulness, interest and importance of programming tasks. Quantitatively, no significant improvement in motivation were found, however, qualitative responses highlighted intrinsic motivation gains. From surveys taken with the students of experimental group, 88% of students also agreed with statements about motivational aspects of task valuation, intrinsic goal orientation, and self-efficacy expectations in learning. Though when it came to anxiety management, 41% of respondents did not agree that their anxiety got reduced. Kilic (2022) presents that use of gamification elements in online project environment can lead to higher motivation and engagement, encouraging students to interact more with each other. The experimental group in the study showed higher measures related to cognitive presence,

social presence and teaching presence than their non-gamified counterpart, implying that gamification noticeably improves the academic environment.

Lastly, for quasi-experimental design studies, Ouahbi et al. (2021) report that addition of gamified quizzes and quiz creation via KAHOOT platform results to majority of students expressing positive attitude with around 90% of the students reporting increased motivation and commitment. Though it should be noted, that this study is not PICO-aligned and the quality of this particular study was deemed rather low, there was no control group involved and as such, there is a high risk of bias involved.

We are left with two remaining PICO-aligned studies: De Santo et al. (2022) and Pratama et al. (2021), which are Iterative development study and Case study respectively. De Santo et al., report that there is a significant and positive link between gamified feedback and laboratory session performance. Students receiving gamified feedback engaged more ($M=14473.24$) and performed better ($M=87.6$) in the laboratory sessions than students from the control group, with ($M=13128.83$) and ($M=63.24$), respectively. Additionally, students receiving gamified feedback requested fewer hints (4.78) than students from the control group (14.62). Pratama et al. (2021) investigated the effects of introducing a gamified system to a programming class and they've found that the gamified group was significantly more motivated (~50%) than non-gamified group and also showed noticeable increase in performance (~15-20%) compared to the control group. However, since the study does not provide discussion and limitation sections and doesn't acknowledge possible methodological pitfalls the authors could've faced, there is a high risk of bias which places the validity of these findings at risk. Nevertheless, the reported results are in line with the previously reviewed studies, supporting that gamification can indeed lead to positive outcomes.

Moving on to non-PICO research, Palaniappan & Noor (2022) report that for their pre-experimental study, the mean of self-directed learning was at the lowest $M=2.38$ and highest $M=4.73$ before the gamification strategy introduction and the lowest at $M=3.65$ and highest at $M=5$ after gamification introduction. The mean of the level in performance post-test was higher ($M = 19.44$) compared to the pre-test ($M = 15.66$).

86.2% completed gamified tasks (badges earned), while 13.8% disengaged (no task completion). 86.2% completed gamified tasks (badges earned), while 13.8% disengaged (no task completion). The authors also report that top performers according to the leaderboard rankings showed higher post-test scores than others, likely driven by competition and recognition.

The remaining seven papers: Yesengazyevna et al. (2022), Trinidad et al. (2021), Dahri et al. (2025), Fidan & Sengel (2022), Chen Sao (2023), Christopher & Waworuntu (2021), Xinogalos & Satratzemi (2022), Pinto & Terroso (2022), all utilized similar methods of data collection, primarily relying on

surveys, questionnaires, and qualitative observations to assess student perceptions toward various gamified interventions.

Across the board, all these studies reported majorly positive findings: Trinidad et al. (2021) who implemented a comprehensive gamified system, report that 85% of participants strongly agreed on the gamified platform ability to enhanced usability, social interaction, and enjoyment, with increased engagement and cultural immersion being the key reported outcomes. Similarly, Dahri et al. (2025) found that over 90% of participants believed AI-based gamification improved motivation, understanding of concepts, and self-monitoring of learning progress through personalized and gamified assessments. Fidan and Sengel (2022) findings show that students feel that competition through score tables significantly motivated them to engage with course materials more actively. While few did express feeling stressed due to time-bound competition, the overall perception of the course was positive, with increased class attendance and student satisfaction. Chen Sao (2023) demonstrated that narrative storytelling, roleplay, and personalized feedback contributed to a strong sense of community and higher motivation in programming courses, with 97% of students reporting enhanced motivation and improved peer collaboration. Christopher and Waworuntu (2021) also noted strong student acceptance of their gamified learning app, with over 74% agreeing it enhanced learning effectiveness and ease of use. Though social influence was rated lower, likely due to limited peer exposure, the general sentiment toward gamification remained favourable. In the study by Xinogalos and Satratzemi (2022), students showed high satisfaction with a gamified SQL learning environment, appreciating the usability and challenge of tasks. The system particularly engaged struggling students, who dedicated additional hours to complete assignments. Finally, Pinto and Terroso (2022) highlighted the value of immediate feedback and peer recognition in promoting motivation and collaboration. All students involved reported increased motivation and engagement, and 90% of them felt that gamification made programming skill development easier.

One particular study I wanted to highlight is by Yesengazyevna et al (2022). The study conducted a survey with students studying in computer science departments at various universities in Kazakhstan. While the survey did not ask about opinions on any particular gamification elements but instead about gamification and use of serious games in programming education in general, regarding the fact that the research was conducted in Kazakhstan, I thought it'd be very fitting to give this paper some special highlight as it provides some relevant information and valuable insight towards my research in particular. According to the survey results, students reported that educational games make learning easier (80%), create a fun environment (57.5%), improve learning retention (42.5%), increase motivation (27.5%), and develop problem-solving skills (12.5%), indicating overall positive perceptions towards gamification and serious games. 75% of students were positive (either "would love to" or

"would like to") about learning programming with educational games, while only 12.5% were undecided and 12.5% were negative, moreover, 52.5% cited a lack of good educational games, signalling that there is a need for development of good gamified tools and serious games for the Kazakhstani market.

These summaries can be found in an Excel table in Appendices.

Having provided brief summaries and key findings of all the included studies, the next section will focus on answering the research sub questions.

Which gamification techniques are most commonly used in programming education?

I decided to excluded the two papers that only used surveys and questionnaires to gather their data as they technically did not use any gamification elements and only gathered opinions on them. Then I addressed the issue of there being too many different gamification elements, by aggregating the one which essentially did same or very similar things, those included: **Points** - aggregated with coins, experience points. Imran H. (2022) study used coins as essentially points, though “virtual coins” from Trinidad et al. (2021) remained as their own gamification element and got renamed to “virtual currency” as they served a different purpose from the “coins” used by Imran.; **Feedback** - Instant, Immediate, Personalized Feedbacks all got aggregated into simply Feedback; **Badges** - got aggregated together with Achievements, as they serve the same purpose; **Progression tracking** - included Progression bars, Performance stats, Progression status and Rank points, as they all serve to track the user’s progress; **Challenges** – also included Quests, I briefly pondered if I should include Weekly missions in here as well but considering their time limited component, I decided to leave them as a separate gamification element; **Unlockable Content** - is also used to refer to task unlocking mechanics and other things requiring progression to get access to, which aren’t available from the start; **Teamwork (Cooperation)** – also includes Jusas et al, (2022), which uses “Local team” and “Global team” but also presents those two gamification elements as separate as each element serves it’s own purpose as well. Finally, in some studies I had to infer the gamification elements used as some did not clearly state what was used in their methodology section. For example, Ouahbi et al., (2021) only states to be using KAHOOT as the gamification intervention, so from that I had to look into KAHOOT and infer that it includes leaderboards, points, time pressure and instant feedback as the gamification elements.

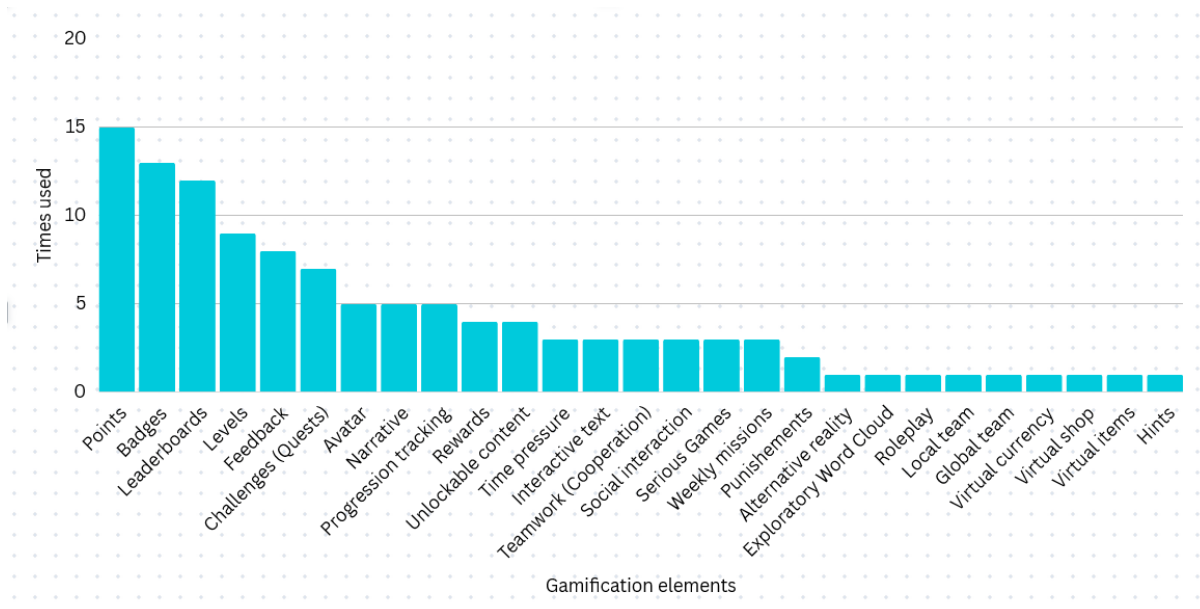


Figure 2. Bar chart of gamification elements and their frequency in included studies.

As we can see, Points, Badges and Leaderboards are the top three most used gamification elements, used in over half of the included studies, Levels, Feedback and Challenges are the next three most utilized ones, followed by a variety of other different things. What I am most interested in, is what kind of effects do particular gamification elements have on engagement, motivation and learning outcomes, which brings us to the next section of the analysis.

How do gamification elements affect student engagement, motivation, and learning outcomes?

From what has been gathered so far, gamification affects engagement, motivation and learning outcomes positively in most cases. In this section, I'd like to go more in-depth, and take a closer look at the most used gamification elements individually.

Starting with Leaderboards because they've already been given some special attention by Cigdem et al. (2023). Cigdem and company's research paper was solely dedicated to documenting the effects of leaderboards on students' motivation, engagement and academic performance. In the study, leaderboards were used to rank students based on their performance on weekly online quizzes. The study's findings show that after the initial engagement boost during the first three weeks, there were no significant statistical differences thereafter in neither engagement, motivation or test results. The author do note however, that weekly online quizzes, regardless of gamification, can positively influence student learning outcomes and that the number of completed quizzes is a significant factor, suggesting the influence of testing effect. The authors also argue that leaderboards could potentially be used to boost engagement short-term but can not sustain it long-term alone, implying other gamification elements should be used alongside it. And indeed it seems to be so, as most other PICO-aligned studies (Imran H, 2022) (Pratama et al., 2021), (Cuervo-Cely et al, 2022), (Huesca et al., 2023), (Kilic, 2022)

show that using leaderboards together with other gamification elements usually leads to positive outcomes, such as increased motivation, engagement and academic performance, among other things.

Badges have also been used as the only gamification element in a study by Imran H. (2022). In the study, there are two experimental groups LLG (low level gamification) and HLG (high level gamification). LLG group only used Badges as their sole gamification element. Regarding engagement, LLG did not have significantly higher score compared to the control group, however, both motivation and performance scores were significantly higher, even if not as high as in HLG group, suggesting that implementation of badges can indeed lead to positive outcomes as is backed up by other PICO-aligned research (Pratama et al., 2021), (Cuervo-Cely et al, 2022), (Huesca et al., 2023), (Kilic, 2022).

Points, as by far the most utilized gamification element, show mostly positive outcomes. They are always used in tandem with other gamification elements, whether for rankings on leaderboards, for calculating player level or player progression status, points serve as a useful tool for measuring player achievement and progress. In that sense, could be considered as almost extension of other gamification elements or as a bridge between traditional test/exam scores and gamified scoring systems. That's why it is nearly impossible to judge their effectiveness on their own.

Levels, Challenges, and Feedback, ranking just below the top three most-used elements, play a supportive role in reinforcing engagement and progression. Levels typically indicate progress and mastery, while Challenges (or quests) add structure and purpose to the learning process by presenting specific goals to achieve or tasks to solve. Feedback, often delivered immediately through points, badges, or other means, keeps students informed of their progress and what mistakes they've made, motivating them to improve and engaging them into immediately correcting their downfalls through further effort. Gamified feedback in particular, helps to promote students' autonomy and speed up the learning process by providing timely feedback and reducing the need to ask for teacher clarification as is implied by De Santo et al. (2022).

To summarize, ultimately, the findings suggest that no single gamification element is universally effective on its own. But rather, thoughtful and well-designed combination of them is what tends to yield the most consistent positive effects on student engagement, motivation, and learning outcomes.

What are the challenges and limitations of gamifying programming education?

Moving onto challenges and limitations, there are several of them which need to be considered when trying to implement gamification in programming education: one such challenge - is the increased workload for educators. It can often take significant amount of time and technical expertise from the teacher to design, implement and maintain a gamified learning environment. They might need to spend

addition time to learn and explain how to utilize the new gamified additions and might also have to develop custom content for their specific course needs, which can add substantial additional workload. (Fidan & Sengel, 2022).

Another challenge is the sustainability of gamification. As noted in Cigdem et al. (2023) study, while addition of gamification elements, such as leaderboards, can lead to short-term boost in motivation and engagement, this effect can diminish over time and if it isn't reinforced with other motivational strategies, then the students will soon return to their baseline level of participation. This means that there is a need for careful consideration and planning when designing the gamified environment, so that after the initial effect of novelty wears off, gamification can still remain relevant and engaging.

The next limitation is that emphasis on extrinsic rewards can backfire. If students become too focused on chasing them (accumulating points, badges, earning experience points) they can lose sight of the underlying educational goals and it might lead to poor academic outcomes later down the line. Students might also try to use unfair ways to gain the rewards as has been noted in Jusas et al. (2022) study, where several students became too focused on earning points that they resorted to cheating. Therefore, considerations should be made about preventing such things from happening, reminding and guiding students towards the righteous path of education.

Yet another challenge is that not all students respond equally well to gamification. There can be individual differences which affect how the students perceive and engage with the gamified content. Differences such as learning styles, prior experience with games, cultural background, competitiveness level, opinion on games and etc. can greatly affect the effectiveness of the approach. Some students may find competitive elements like leaderboards demotivating or anxiety-inducing (Fidan & Sengel, 2022) or gamification may have no significant effect on students not particularly interested in gamification, as could be the case in García-Iruela et al. (2022), where the gamified programming course was mandatory and attended by non-CS majors, who likely didn't have as much interest in programming and gamification as CS majors and that could lead to poor gamification performance.

This all means that while gamification offers promising benefits for programming education, it should be implemented thoughtfully. An approach that takes into consideration all the potential limitations and challenges and attempts to work around them while mindfully implementing the gamification elements - is the key to maximizing gamification's long-term effectiveness.

Discussion and Project Implementation

Summary of Key Findings

This study set out to investigate the effectiveness of gamification in programming education through a systematic literature review and then to apply the findings in the development of a gamified web platform. The SLR of 20 studies reveals a generally positive trend toward the use of gamification in programming education: implementation of gamification elements tends to enhance student motivation, engagement and learning outcomes. The results from PICO-aligned studies provide the strongest evidence base and qualitative data from non-PICO studies reinforces these trends by providing user perceptions and experiential feedback.

General Trends and Effectiveness

Among the PICO-aligned studies, majority reported statistically significant positive outcomes in either academic performance, engagement, or motivation. Randomized Controlled Trials (RCTs), like those by Imran (2022) and Garcia et al. (2023), demonstrated significant improvements (around ~15–20%) in academic metrics, engagement and motivation. Quasi-experimental studies generally shared the same trends, though a few had some mixed results. However, even those studies, that reported statistically insignificant academic improvements, also typically noted gains in student motivation and engagement or at the very least gains in their perceptions of it. This suggests that while gamification may not always show immediately apparent results, it can still provide positive outcomes and with additional development, can lead to sustained learning benefits later down the line.

Non-PICO studies, though methodologically less rigorous, uniformly reported positive perceptions of gamification. These included increased motivation, engagement, sociability and collaborative behaviour, user enjoyment and satisfaction, and some others, indicating that students generally react positively to gamified environments. Especially relevant is the study by Yesengazyevna et al. (2022), which captures attitudes of students in Kazakhstan. Their findings affirm the regional relevance of gamification, with majority expressing a desire to learn programming through educational games and gamification and also citing a lack of good gamification products, signalling that there is a demand for more gamification, and affirming my gamified coding platform's relevance.

The SLR also identified gamification elements most commonly used. Among gamification elements, points, badges, and leaderboards were the most widespread, appearing in more than half the studies. Leaderboards demonstrated limited effectiveness when used alone, initial engagement gains often faded without additional motivational supports, as seen in Cigdem et al. (2023). Badges, even when used in isolation in Imran's (2022) Low-Level Gamification group, led to some improvements in motivation and academic performance, though when used in combination with other gamification elements, the metrics were much higher. Points were shown to be used as a cornerstone of many gamified

approaches, often acting as a connective tissues, connecting different gamification elements together. Some other elements of note include feedback, especially personalized and immediate, which consistently contributed to improved learning outcomes by making students more aware of their progress and areas for improvement, challenges and quests, which provided students with tangible goals and set up a clear way to move forward, and ways to track progress, such as levels, were shown to also affect motivation and engagement quite positively. However, and perhaps the most importantly, findings show that no single gamification element is universally effective and that combining multiple different ones thoughtfully leads to more positive results.

Project Overview

The project aim is to develop a gamified web platform that can help improve student motivation, engagement, and learning outcomes in programming education by leveraging gamification elements and easy-to-use coding interface. The insights gained from the systematic literature review were very helpful when considering which gamification elements are best to implement. Points, badges, leaderboards, rankings, levels and progress tracking were chosen for their proven effectiveness and relative ease of implementation into the project. The platform also features a web-based coding editor with some beginner friendly programming languages (Python, JavaScript, HTML), and a list of problems to solve. Each user has their own personal cabinet, where the problems they solved and badges they've earned get tracked, as well as their level, rank and position on the leaderboard.

The target audience for this project are beginner-level programming students, particularly those in second school (technical college) and ones in university introductory programming coursesw, as well as self-learners seeking structured and engaging programming practice. By utilizing structured gamified approach with engaging features and feedback systems, the platform is designed to appeal to students who may feel overwhelmed and be struggling with motivation from traditional programming instruction.

Project Functional Requirements

The following are the core components of the gamified coding platform:

User-side Functionalities:

- **User Registration and Authentication:** New users can sign up with email and password, while returning users can log in to access their progress.

- **Problem-Solving List and Interface:** Users can select from a list of categorized coding challenges and solve them using a web-based code editor.
- **Gamification Feedback System:** On solving a problem, users earn points and may unlock badges. Their progress is visually tracked through experience bars and levels and summary statistics in the user cabinet.
- **Leaderboard and Ranking:** A live leaderboard displays the top-performing users, ranked by total points.
- **User Profile Cabinet:** Each user has a dedicated dashboard showing their statistics badges earned, levels reached, completed problems, and their leaderboard position.

Admin-side Functionalities:

- **Problem Creator Interface:** Admins can quickly add new problems through the dedicated problem creator.
- **Administration Cabinet:** Admins manage users and databases here.

System Architecture

The platform is built using typical frontend-backend structure, where the client (frontend) interacts with the backend through HTTP requests handled by the Django framework. Docker application is used to containerize the project, simplifying deployment and ensuring consistency across different environments and operation systems.

Components:

Frontend:

- HTML templates rendered with Django's templating engine.
- CSS and JavaScript used for styling and interactivity.
- The web-based code editor is integrated using JavaScript and Pyodide.

Backend:

- Built with Django.

- Handles user authentication and gamification mechanics such as score calculation and level updates.

Database:

- PostgreSQL serves as the relational database.
- Manages persistent user data.

User Flow

The user flow consists of the following key components:

1. **Registration/Login Page**
2. **Explore Page**
3. **User Cabinet Page**
4. **Code Editor Page**
5. **Problem List Page**
6. **Problem Solving Page**

When first coming to the platform, the user is faced with the login screen, where they are asked to type their username and password. If the user does not have an account, they can go to the registration page to create one. After they've done that and logged in, they are redirected to the Explore page. Here, a brief overview of the website and its features should be presented, using the Header bar (present on any page) the user can click on the main Explore, Problems or Editor links. The Explore will take the user back to the Explore page, the Editor will take the user to the web-based code editor, where the user can practice their coding skills in HTML, JavaScript and Python. Clicking on the Problems link, leads to the Problems List page, which contains a list of problems for the user to solve and leaderboard which displays users who have earned the most points by solving the problems. Upon clicking a problem, the user is redirected to the Problem Solving page, where they are presented with the problem description and the modified web-based coding editor to solve the problem. Upon finishing writing the code and running it, the user can submit their solution and if they are correct, the problem will be marked as solved and the user will gain points according to the problem's difficulty and perhaps a badge if they met certain requirements.

At the rightmost part of the header, there is a link called Cabinet. Clicking it, user can access their personal cabinet, which shows what level the user is, their rank, how many problems they've solved, what badges they've earned as well as some other things. Here the user can also edit their profile.

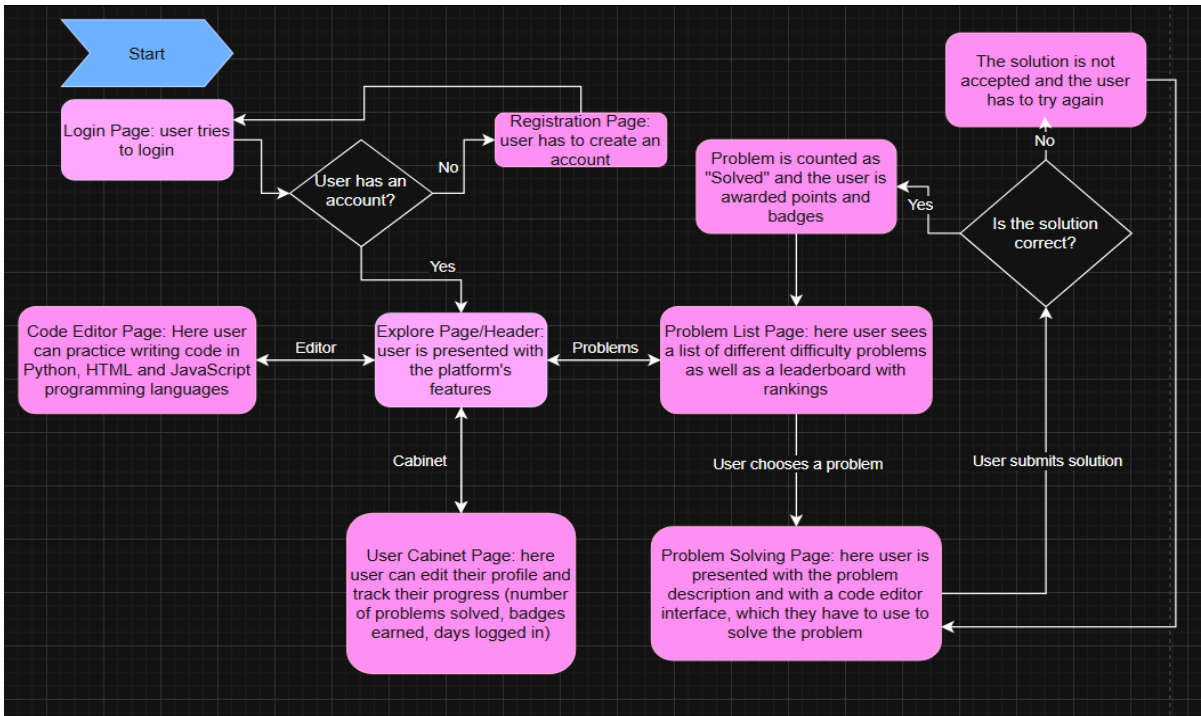


Figure 3.

Market analysis

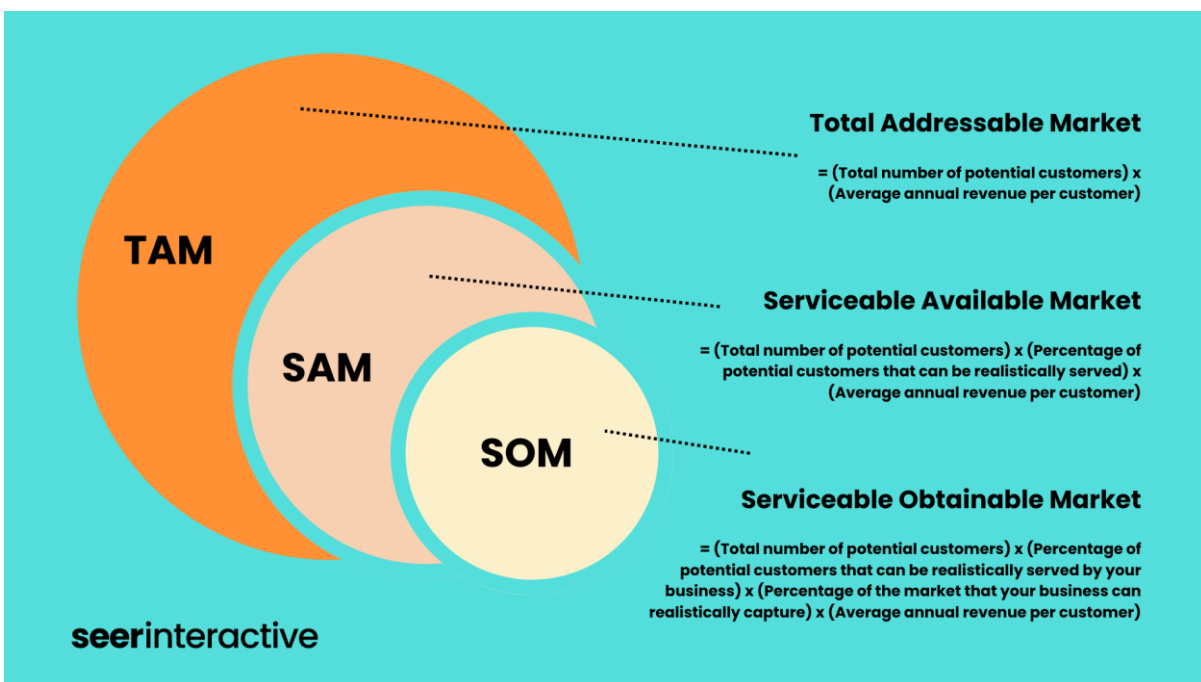


Figure 4.

In terms of market potential, this project aims to occupy a niche within the **EdTech sector**, which according to DigitalBusiness.kz (2023) was worth 27,35 billion tenge in 2022. The biggest segment in Kazakhstani EduTech is the K12 segment, taking 63,18% of market share in 2022, followed by

Additional Professional Education (ДПО) at 25,54%, Developers and platforms at 6,5% and other at 4,78%.

The Total Addressable Market (TAM) refers to the overall revenue opportunity available if the product were to capture 100% of the market globally. The global EdTech market was valued at from \$160 billion USD to \$250 billion USD in 2024, according to multiple sources (Grand View Research), (Straits Research), (Imarc), (Market.us, 2025) and is projected to continue growing rapidly. Within this, the global coding education segment, especially platforms offering gamified learning like CodeCombat or Codecademy, represents a multibillion-dollar opportunity.

The Serviceable Available Market (SAM) narrows the TAM to focus on specific geographic or demographic segments that this project could realistically serve in the near term. For this platform, the SAM includes beginner programming learners within Kazakhstan, particularly students in technical colleges, universities, and high schools offering programming curricula. Given that K–12 accounts for over 60% of the EdTech market in Kazakhstan and technical colleges/universities form a substantial portion of ДПО (25.54%), it is estimated that the SAM could represent several billion tenge in potential value annually, especially as interest in digital skills continues to rise post-pandemic.

The Serviceable Obtainable Market (SOM) is the portion of the SAM that this solo-developed could realistically reach within the scope of this diploma project. Given limited time and resources and the mostly academic nature of the project, the initial reach would be rather small, likely being deployed within a single institution and tested in a single class or department. The realistic obtainable market in the short-term future is minimal, however, it should be considered that the true value of the project lies not in the immediate commercial return, but instead, in its proof of concept and demonstrated potential, showcasing implementation of current trends in gamified learning. In the long-term, if the project is given more proper development time, the platform could improve and scale into a substantial segment of the Serviceable Available Market.

Market Comparison

In the broader landscape of gamified programming platforms, my project can find its niche between problem-solving platforms like LeetCode and educational environments like W3Schools or CodeCombat. LeetCode focuses on advanced algorithmic challenges often used for interview preparation and lacks pedagogical guidance or beginner-friendly onboarding. On the other hand, W3Schools offers a simple, interactive environment for trying code snippets but lacks gamification and structured progression. Compared to them, this project uniquely combines the structured problem-solving model of LeetCode with a lightweight, browser-based code editor similar to the one in

W3Schools, while also adding gamification mechanics to enhance motivation and user engagement. It also focuses on educational alignment, targeting beginner to intermediate learners in higher education settings something neither LeetCode nor W3Schools explicitly optimizes for.

Furthermore, while platforms like CodeCombat and Scratch gamify coding education, they cater primarily to K-12 or younger audiences and rely heavily on visual or story-based interfaces. In contrast, this platform uses text-based programming and real-world syntax, offering a more relevant experience for university-level learners. Its design strikes a balance between educational rigor and motivational scaffolding, making it a more suitable supplement for programming curricula in universities.

On the local side, there do not appear to be any direct competitors in the Kazakhstani market. Majority of similar projects are catering to K-12 students and under. One of the more similar, well-established Kazakhstani EduTech projects, for example – CodiPlay, is primarily targeting kids. That brings me to the project's strengths:

- **Higher Education Focus:** The project aims to take a relatively unexplored niche in the market, catering towards beginner higher education students, while others primarily focus on younger K-12 audience.
- **Ease of Use:** The web-based interface, powered by Django and Pyodide, requires no local setup, making it easy for students to access coding exercises just using a web browser.
- **Immediate Feedback:** By executing code in the browser and providing instant feedback, the platform encourages trial-and-error learning and speeds up the learning process.
- **Gamification Elements:** Implementation and utilization of gamification elements helps the project stand from the more traditional education focused platforms.

However, while the platform has strong future potential, there are also currently a number of weaknesses:

- **Few Gamification Elements:** The implemented gamification elements are relatively simple and few, lac of more robust features could limit long-term engagement.
- **Limited Number of Programming Languages:** There are currently only three programming languages supported, which limits the number of courses the platform is applicable for.
- **Very basic design:** The platform, while functional, is very basic and acts more as a proof-of-concept than an attractive educational platform.

Monetization Strategy

Monetization can be achieved through a freemium model, offering core features for free to the students and limited access to the administrative functions to the educators, and charging for premium features such as teacher cabinet and dashboards. Another viable approach is business-to-business licensing, partnering with schools, universities, or coding bootcamps to provide institution-wide access.

Additional income streams may include placing advertisements on the platform, seeking sponsorships, and providing certificates of completion to users for additional fees (buying premium).

Limitations and Future Improvements

Limitations of the Research

Despite the structured methodology of this study's Systematic Literature Review (SLR), several limitations need to be acknowledged:

1. Access Limitations

The review was limited to open-access studies. This means that potentially relevant research locked behind paywalls likely has been excluded and it affects the completeness of the findings.

2. Publication Bias

Peer-reviewed journal articles and conference papers made up the majority of the review. This means that there could be a risk of publication bias, which could skew the results in favour of positive interpretation of gamification effectiveness because studies that report positive outcomes are more likely to be published and, consequently, to be included in this review.

3. Single-Researcher Bias

Because this study was carried out by a single researcher, its scope and objectivity are inherently limited. Because of that, while the processes of screening studies, extracting data, and synthesizing findings, were carried out with methodological care, they are still at an increased the risk of oversight or subjective interpretation.

4. Selection and Scope Constraints

The specific inclusion and exclusion criteria of the SLR may have filtered out studies with relevant but non-standard or uncongenial methodologies or formats. Also, research not in English was not included, potentially limiting gain of unique cultural insights and regional perceptions. Furthermore, due to time constraints, studies were gathered from select few databases, potentially excluding all the relevant research in all the other places.

5. Variability of Study Designs

The research design, sample size, gamification components, and outcome measurements of the

examined studies varied greatly. This hindered the ability to do meta-analytical synthesis and made it more difficult to directly compare or aggregate data, making the research resort to a narrative synthesis instead. Some studies also lacked statistical rigor, making it more difficult to draw clear conclusions.

Limitations of the Project Development

The development of the gamified web-based coding platform is no easy task and I've been faced with several limitations through the process:

1. Time Constraints

The limited timeframe available to develop a functional and meaningful product, while balancing the dual responsibilities of conducting a systematic literature review and simultaneously implementing a working prototype is no easy task. This had led to prioritizing core features over advanced or polished functionality.

2. Single-Developer Workload

Since I worked on the project alone, I was solely responsible for managing all the steps in the project development, while simultaneously conducting academic research and writing the thesis paper. This created a steep workload and exacerbated the pressure of time. It also meant that research and development decisions were made without the input of a broader team, and were all reliant on my own expertise and knowledge.

3. Inexperience with Web Development

This project is my first real experience in full-stack web application development. As a result, I had to spend significant time figuring things out. While this led to my deeper understanding of Django, PostgreSQL, Docker, and full-stack development techniques, it also slowed down the development progress and limited the implementation of more advanced or optimized designs.

4. Lack of User Testing and Feedback

Due to resource and time constraints, the platform has not yet undergone systematic usability testing or feedback collecting from intended users (such as students or teachers in higher education).

5. Restricted Feature Set

To fit within the time limits, many desired features, such as AI-powered feedback, more robust and extensive gamification features and dashboards, or multi programming language support could not be implemented in this version.

6. Scalability and Security Limitations

While there are some basic level security measures, the platform requires more extensive test

and review before production deployment in an educational environment, in addition, the current code, while functional, will likely require refactoring and optimization if the project is to be launched in bigger scale.

Future Work

The systematic literature review contributes to the field of gamification in programming education and provides a number of new study direction. A lack of research that focuses at the effects of particular gamification is one major gap that has been found. More experimental research needs to be done to better examine the specific impact of each gamification element, both individually and in various combinations with other elements, to better understand which configurations lead to the most effective learning outcomes.

Additionally, the majority of the examined research focus on the relatively short-term effects of gamified interventions. To determine whether gamification produces long-lasting gains or if its advantages diminish with time, longitudinal research monitoring the long-term effects on academic performance, engagement, motivation and information retention is recommended.

Another possible direction would be to examine the influence of cultural and contextual factors, such as student demographics, course design, and teaching style. This could allow educators to better apply gamified approach to different educational settings.

Lastly, more randomized controlled trials (RCTs) and quasi-experimental design studies are needed to develop a more broadly applicable and empirically supported understanding of gamification in education and in general.

On the development side, there is much to do and many directions in which the gamified web platform can be expanded and improved:

1. User Testing and Pedagogical Evaluation

Conducting systematic user testing with educators and students in higher education settings is an essential next step. Getting both qualitative and quantitative feedback will provide important information about platform's usability and shortcomings, as well as user preferences and requests. This can direct future design choices and development.

2. Feature Expansion

Due to time constraints, mostly basic features were implemented, so the next logical step is the feature expansion:

- Additional programming languages support can be added to accommodate a broader range of programming curriculum and learners.
- AI-assisted feedback can be implemented for more personalized guidance.
- Multiplayer or collaborative coding challenges can be developed to improve teamwork and promote competition.
- Already existing gamification elements' functionality and overall website design and aesthetics can further be expanded and refined, insuring smoother user experience.

3. **Improving Deployment Readiness**

Refactoring the code and optimizing the project architecture to be more scalable, running tests to find bugs and potential exploits in the platform, as well as adding more robust security features for protection against malicious users, are the adjustments that need to be made in order to ensure the project is well-prepared for the real-world deployment.

4. **Content Growth**

Expanding the problem adding functionality for the instructors, adding problem proposing functionality for student developed problems and perhaps leveraging AI to create course-relevant problem could all allow the platform's problem list to grow and expand.

Conclusions

This study set out to investigate the effectiveness of gamification in programming education through a systematic literature review and to apply those insights in the development of a practical, gamified web-based coding platform tailored for use in higher education. The systematic literature review of 20 studies reveals a generally positive trend toward the use of gamification in programming education: when thoughtfully designed, implementation of gamification elements tends to enhance student motivation, engagement and learning outcomes.

Points, Leaderboards and Badges were identified as the most commonly used gamification elements and it was found that their effectiveness depends on context, balance, and alignment with educational goals. Notably, the findings highlight that no single gamification element is universally effective, strategic implementation of combination of gamification elements is what can avoid pitfalls like extrinsic reward overemphasis or educator workload strain and leads to significant improvements in student motivation, engagement, and academic performance.

The developed web-based platform applies gained insights into practice, creating a structured, interactive gamified environment for beginner programmers. By prioritizing accessibility, real-time

feedback, and progress tracking, the platform aims to fill the gaps in existing resources, particularly for higher education students and self-learners in Kazakhstan. The platform included features like intuitive code editor, utilization of problem-based learning model, and a gamification system based on effective elements identified in the systematic literature review aim to create a compelling and useful practical programming learning tool.

Despite limitations such as: time constraints, limited resources, and the developer's relative inexperience, the project demonstrates a promising gamified educational platform prototype made specifically for programming education. As digital education continues to evolve, this work contributes a regionally relevant, scalable solution that can be iteratively improved through further research and development.

Overall, this study shows that while gamification is not an universally applicable solution, it holds strong promise when designed thoughtfully and deployed mindfully for programming education. The combined academic and practical contributions of this project lay a strong foundation for future exploration, both in the scholarly understanding of gamification and in the continuous enhancement of technology-supported learning tools.

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Appendices:

Appendix 1 — Quality Assessment of Reviewed Studies



Quality
Assessment.xlsx

Appendix 2 — Short Summaries and Some Other Information of Reviewed Studies



StudyTable.xlsx