Designing a Practical Course from a Gamification Perspective: Students' Insights from Informatics Education

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Abstract: Gamification is a powerful instrument in the educational process if applied with care, considering the holistic learning experience. Literature has shown that using game-based mechanisms can motivate and engage students to participate actively in the learning process. This study investigates students' motivation and engagement to participate in practical courses developed based on a holistic gamification approach. In this paper, we present the results of a case study in a Swedish university. In one of our practical courses, we designed and implemented gamification concepts (bonus points, real-life scenarios, and role-playing). The course *Software Architecture* was designed and developed from scratch with the explicit aim of integrating gamification into its structure and delivery. After each lecture, we planned a workshop (with voluntary participation) with gamification elements, applying the learning outcomes. To investigate students' insights, we distributed a research survey, complementing the general course evaluation survey, at the end of the course, during which 60% of the enrolled students were present (enrolled students:100). In total, we collected 50 responses. The preliminary results show positive statistical significance on the students' motivation to participate actively and engage in the course; moreover, it encourages positive collaboration among the students and helps students better understand the course content. However, students experience different gamification elements (e.g., bonus points and role-playing) differently, i.e., role-playing seems to make students struggle more to apply it to a real-case scenario. Moreover, there are indications that the implemented gamification approach added extra stress and pressure to the students. We also identify implications that awarding bonus points, which are collected during seminars and used on the final exam, at the group level instead of an individual level, cannot be a fair approach. Overall, the results indicated that the students are motivated and engaged to participate in courses developed with a holistic gamification approach. The study will be replicated with a different group of students and in a theoretical course to better understand how gamification designs can be applied in different types of courses.

Keywords: Gamification, Motivation, Engagement, Bonus points, Informatics

1. Introduction

A common definition of gamification is proposed by Kapp (2012,p.10), as "*using game-based mechanics, aesthetics, and gamification to engage people, motivate action, promote learning, and solve problems."* When applied correctly, gamification should encompass the entire course, e.g., engaging storytelling, realistic scenario development, and meaningful rewards. Literature has shown that gamification is a powerful instrument in the educational process. If applied with care, students are motivated and engaged to participate actively in the learning process.

Gamified designs are still very rare in higher education. The gamification concepts utilised in the courses in higher education are often implemented as pointsification (Hellberg & Moll, 2023), bonus points (Miglietti, 2021; Moll and Gao, 2022), storytelling (Csikar and Stefaniak, 2018), role-playing (Beidatsch and Broomhall, 2010), checklists (Molléri et al., 2018), and simulation (Chatzipetrou et al., 2018). However, there is a lack of studies focusing on gamifying an entire course from a gamification perspective.

To address this gap, this study has the following two objectives. The first objective is to design a practical course from a holistic gamification perspective. The second objective is to investigate students' motivation and engagement to participate in this course through a survey conducted at the end of the course. More specifically, we distributed a research survey complementing the general course evaluation survey.

Aligned with the first objective, this study presents the results from a case study at a Swedish university. In one of our practical courses, we designed and implemented gamification concepts (bonus points, real-life scenarios, and role-playing). The course*, Software Architecture,* was designed and developed from scratch to integrate gamification into its structure and delivery explicitly. After each lecture, we planned a workshop (with voluntary participation) with gamification elements applying the learning outcomes.

Regarding the second objective, a survey was designed to gain students' insights regarding the implemented practical course. First, it explores how students perceive gamification in terms of its impact on their learning,

motivation, and engagement. Furthermore, it examines whether and how gamification influences students' experiences of stress and their ability to manage time effectively. Moreover, it addresses students' perceptions of fairness, particularly how gamified elements affect grading and assessment practices. We aim to provide a comprehensive understanding of the benefits and challenges of integrating gamification into the course design of practical courses.

This study offers research-based insight into how a practical course can be developed from a holistic gamification perspective and how it impacts students' motivation and engagement. It highlights positive outcomes and challenges grounded in a real-case study. The findings are relevant for educators interested in designing engaging, student-centred, holistic learning experiences using a gamification approach.

The remainder of the paper is structured as follows: Section 2 outlines the related work. Section 3 describes the course case used in this study. Section 4 presents the research methodology of our work. Section 5 presents the results of the analysis. Finally, in Section 6, discussion and conclusions are provided.

2. Related work

Gamification has been used as an approach (Hamari, Koivisto and Sarsa, 2014) to enhance students' motivation and engagement (Rassuli, 2022) and to improve students' learning outcomes (Moll and Gao, 2022). Learning can become more interactive by integrating gamified elements, such as bonus points, badges, and role-playing. Previous studies have also found that applied gamification in education can improve students' learning outcomes (Çakıroğlu et al., 2017; Moll and Gao, 2022). For example, Çakıroğlu et al. (2017) reported that using bonus points positively influenced students' academic achievement by increasing their engagement in an ICT course. However, some potential concerns with gamification implementation in education exist, such as limited classroom time for gamified activities (Hidalgo, Astudillo, and Castro, 2023) and fairness in gamification-based grading (Moll and Gao, 2022).

One of the core concerns with gamification in education is the limited time available for gamified activities, particularly in courses with large numbers of students and limited course seminar durations. These constraints may prevent all students from participating equally in gamified activities. As a result, this can raise issues, such as fairness in the learning experience with the implemented gamification. For instance, role-playing as a pedagogical tool has been used in many different subjects in higher education, such as history (Beidatsch and Broomhall, 2010), computing (Hingle et al., 2021), and requirement engineering (Svensson and Regnell, 2017). Role-playing can create a friendly learning environment by breaking the ice among students and enhancing their motivation to learn, as demonstrated by Beidatsch and Broomhall (2010). However, its implementation within time-limited course structures can also restrict student participation. For example, Hidalgo, Astudillo, and Castro (2023) identified limited classroom time as a challenge to executing role-playing in software engineering education. The limited time on role-playing could create an unequal learning experience for students, which could affect students' perception of the fairness of the implemented role-playing.

Another critical issue relates to assessment transparency and equity in gamification-based grading. Molls and Gao (2022) reported that students perceived inequities when awarded bonus points from the implemented gamification were not distributed fairly in group settings. In such contexts, individual contributions often vary. However, bonus points may be awarded collectively or without clear assessment criteria. This would lead to students' concern about the fairness of grading and the implemented gamification. It would be interesting to explore the fairness of gamification-based grading from students' perspectives further.

Gamification can also introduce stress for students. Competition among classmates can lead to psychological reactions, such as stress (Canning et al., 2020). For instance, some students may experience increased stress when they observe classmates performing well on tasks or struggling to meet expected learning outcomes. In addition, gamified elements, such as bonus points, can introduce extra course tasks, which can be perceived as an additional study load. For instance, Domínguez et al. (2013) found that time availability was the most frequent reason students indicated for being unable to participate in gamified activities in education. Previous studies by Alsswey and Malik 2024 found that stress was reduced among students following the application of gamification tools such as Kahoot! in educational contexts. This study also aims to further investigate students' perception of stress associated with applied gamification in higher education.

3. The Software Architecture Course

The course used as the case in this study is the continuation-level mandatory methods course "Software Architecture" in the system development bachelor's program at a Swedish university. The course aims to equip students with basic knowledge and skills in software architecture and its role in developing and maintaining software systems. This understanding is critical in a digital era where software systems grow increasingly complex and interconnected. The course was given for the first time in the spring of 2025; hence, this paper focuses on the first course round.

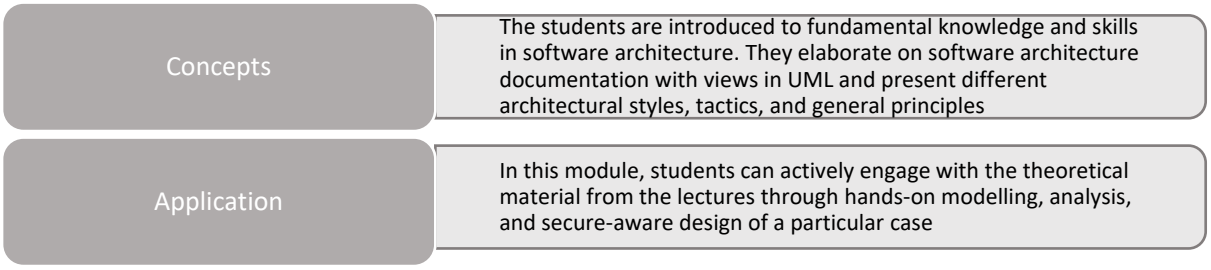

Figure 1: Course modules

3.1 Course Structure

The course design employs a holistic gamification model, comprising seven lectures, three workshops, one presentation seminar, and a concluding written examination. The above-mentioned concepts and application modules run in parallel, with lectures arranged in the concepts module and project work, including the workshops, a presentation, and a written report, in the application module.

The project is carried out in groups of 5-6 students. The workshops, which are designed to support students in their project work, are attended voluntarily; therefore, active participation is not mandatory. The project groups receive their assignments at the workshop and do not prepare in advance. However, they are encouraged to read certain chapters in the course literature before each respective workshop. Each seminar has a different setup, as described below. The focus of the workshops was:

- Identifying, capturing and organising information about class, responsibilities and collaborations.
- Identifying system components, drawing component diagrams, and introducing architectural constraints.
- Validate a software architecture by using the architecture trade-off analysis method.

The concluding written exam consists of 11 questions, each worth between 2 and 6 points. The maximum score was set at 30 points. For a passing grade, the students must earn at least 15 points (50%); 23 points are needed (80%) to pass the exam with distinction.

3.2 A Gamified Course Design

Although workshops and seminars are crucial in higher education for applying theoretical knowledge hands-on, students often prioritise studying for final exams, which typically determine their grades, leading to low attendance at voluntary sessions like workshops. This focus on exams may help students pass, but limits their deep understanding gained through practical engagement. A gamification approach (see Fig. 2) was introduced, offering bonus points—0.5 per workshop, 0.5 for the oral project presentation, and 1 for the written report, totalling up to 3 points—to motivate participation and deeper learning. Each workshop uses real-life case studies relevant to software architecture to encourage active learning. In the first workshop, students apply the Class-Responsibility-Collaboration card method to analyse scenarios by identifying actors and actions. In the second, they engage in role-playing exercises to explore system components, create diagrams, and discuss architectural constraints, gaining insight into different and conflicting roles in architectural design. Finally, in the third workshop, storytelling was applied using case-based real scenarios to validate the security-awareness of the developed architectural model.

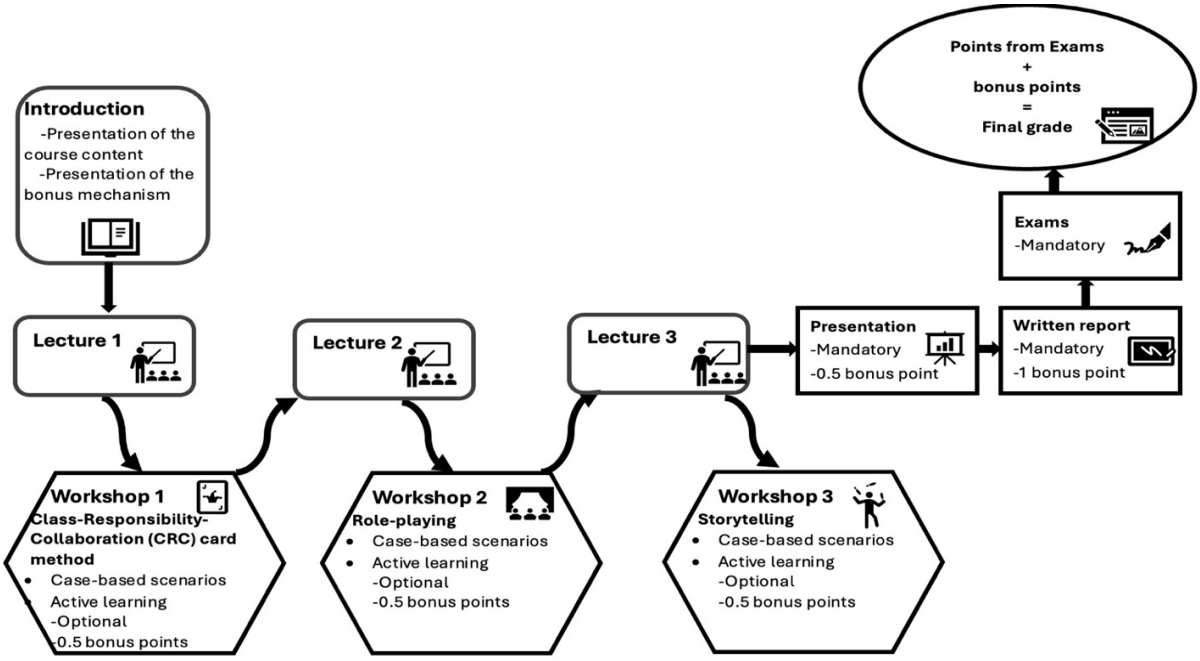

Figure 2: A diagram of the course setup, emphasising the gamification approach

3.3 Assessment and Grading

Three assessment criteria were developed for earning 0.5 bonus points from each workshop. Figure 3 gives an example from the second seminar that included the role-playing exercise. The group needs to fulfil all criteria to get the bonus points.

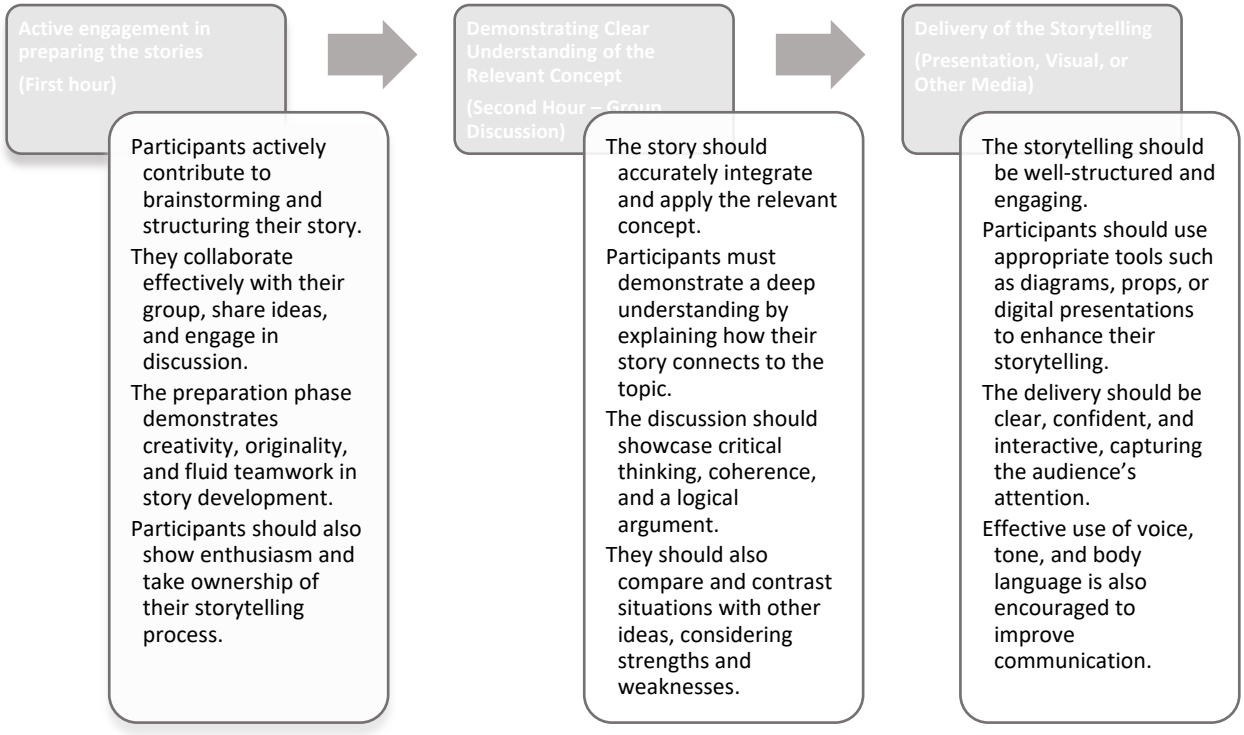

Figure 3: Bonus point criteria: Second workshop

Likewise, three assessment criteria for bonus point quality were also derived regarding the oral presentation of the projects Figure 4). As was the case for the workshops, a maximum of 0.5 points could be awarded, and all criteria needed to be fulfilled to get them. For the written project report, five assessment criteria were derived

for bonus point quality (Figure 5). If the students fulfilled all of them, they earned one bonus point; if they fulfilled 3-4 criteria, they earned 0.5 points.

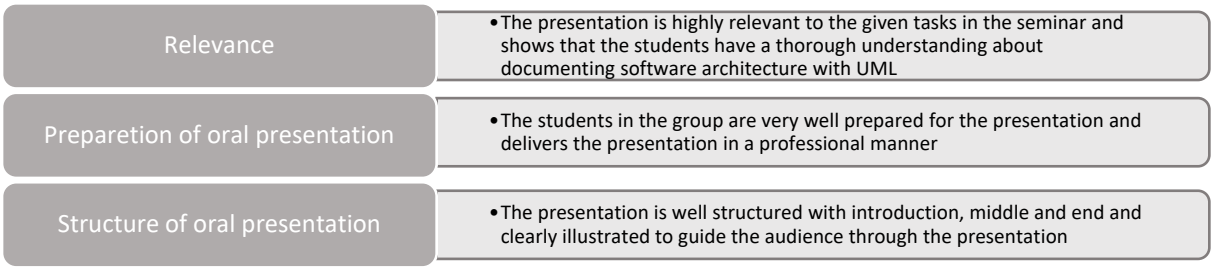

Figure 4: Bonus point criteria: Oral project presentation

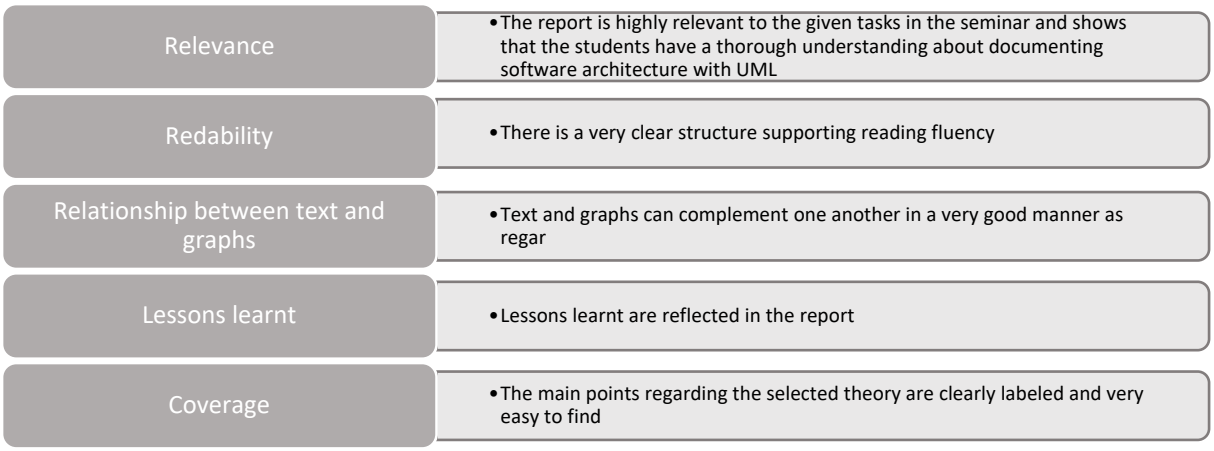

Figure 5: Bonus point criteria: Written project report

Overall, a student can get up to three bonus points, all earned at the group level and transferred to the final exam. If a student gets all bonus points from the above-mentioned course activities, 12 points will be enough for a Pass and 20 points for a Pass with Distinction (instead of 15 and 23 points, respectively). It is important to note that only whole bonus points can be transferred to the final exam. For example, a student who gets 1.5 bonus points in total, only one extra point is transferred to the final exam.

4. Research Methodology

4.1 Research Questions

In the second part of this study, we carry out a survey. The following research questions drive this survey:

RQ1: How do students perceive the use of gamification in the course, particularly in terms of its impact on their learning, motivation, and engagement?

RQ2: In what ways does gamification influence students' experiences of stress and their approaches to time management within the course context?

RQ3: How do students evaluate the perceived fairness of gamification elements, including their influence on grading and assessment practices?

4.2 Survey Design

The questionnaire consisted of 23 questions, 22 closed-ended questions, and one open-ended question. The questions are referred to as Q1-Q23 and are available in Table 1. The questionnaire contained five sections. The first section is *Demographics*, and the following sections target the *Perceptions of Gamification in the course*, *Stress and Time Management*, *Fairness in Gamification and Grading* and *Final Remarks* (open-ended). The overview of the questionnaire is available in Figure 6 and Table 1.

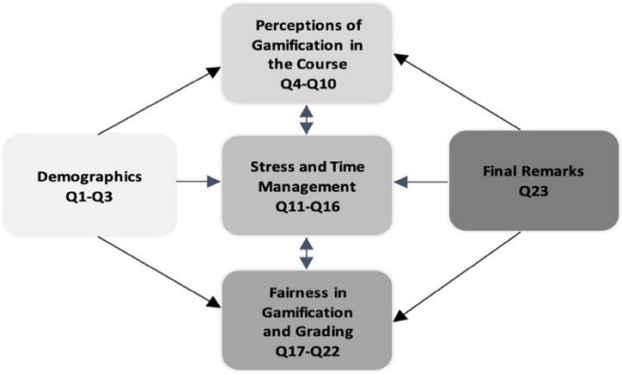

Figure 6: Overview of the questionnaire

4.3 Description of the Data Set

The survey occurred during the last session of the gamified course described in Section 3, during which 60% of the enrolled students were present (the total number of enrolled students was 100). In total, we collected 50 responses.

Regarding the demographic characteristics of the students, we considered three different factors: The subject of their study, their gender, and their experience with the use of gamification in education. Since the survey was conducted at a Business school, the students could come from different subjects. However, in our case study, 96% of the students came from informatics, and only 4% were from a different subject, which is an expected result since the course offered, *Software Architecture,* is a practical course in the software engineering field. Regarding gender, the sample was equally distributed, with 52% male and 44% female students. Furthermore, regarding their experience with the use of gamification in education, i.e., in how many courses they have experienced the gamification element, 14% have never experienced the gamification element before, 76% experienced gamification in 1-3 courses, and only 10% have experienced the gamification element in more than three courses.

Table 1: The questionnaire questions

	Questions
Q1	Which study program do you admit to the university?
Q2	What is your gender?
Q3	In how many courses have you experienced the use of gamification in education?
Q4	The gamification approaches (e.g., role-playing, bonus points) made the course more engaging (e.g., attending workshops)
Q5	The use of role-playing helped me better understand the course content
Q6	The bonus points system motivated me to participate more actively.
Q7	The gamification approaches (e.g., role-playing, bonus points) motivated me to gain a deep understanding of course content.
Q8	Gamification encouraged collaboration with my classmates.
Q9	The implemented gamified approaches contributed to my overall learning experience.
Q10	How did the implemented gamification approaches affect your willingness to complete course tasks?
Q11	How would you rate your overall stress level due to the use of gamification during this course?
Q12	The gamification approaches (e.g., role-playing, bonus points) added extra pressure.
Q13	The gamified activities helped reduce my stress by making learning more enjoyable.
Q14	I felt anxious about earning bonus points for achieving high scores on the final exam.
Q15	I planned my study schedule effectively to accommodate the implemented gamification approaches (i.e., bonus points).
Q16	The bonus points system encouraged me to complete tasks in a timely manner.
Q17	The gamification approaches (e.g., role-playing, bonus points) were implemented fairly for all students.

Questions	
Q18	The role-playing activities provided equal opportunities for all students to participate and succeed.
Q19	Awarding bonus points at the group level, rather than the individual level, was a fair approach for all students.
Q20	The bonus points system was applied in a way that fairly rewarded students' work.
Q21	Bonus points assessment from a single teacher, rather than two teachers jointly, was a fair approach for all students.
Q22	The assessment criteria were communicated clearly and consistently.
Q23	Any other comments on the use of gamification in this course or informatics education in general.

4.4 Data Analysis

To summarise overall trends and respondent characteristics, we adopted a quantitative approach and used descriptive measurements. The descriptive measurements we used were frequencies and percentages for the nominal variables, Mean value, and Standard Deviation for Likert scale variables. Moreover, to investigate if students' insights on gamification are affected by their demographic characteristics, i.e., gender or experience with gamification concepts, we used the Chi-Square test of association. To examine the strength of associations, we use Cramer's V test. Cramer's V measures the strength of the association of a nominal-by-nominal relationship. Finding an association, however, did not provide us with further details about this association (which cases are 'responsible' for this association). Therefore, following up on our statistically significant results, we performed post hoc testing using adjusted standardised residuals (Agresti, 2013). The analysis was conducted using the statistical package SPSS.

4.5 Validity Threats

The population under study, i.e., students at the Informatics Department, is large and highly heterogeneous. Consequently, we assume that the size of the population could be regarded as infinite. Under these circumstances, determining the appropriate sample size for our study is dwarfed by the importance of selecting a representative sample. Our survey was not designed to make strong quantitative conclusions about all the students belonging to the Informatics Department, but rather to identify larger trends.

Next, we discuss four aspects of validity (Runeson and Höst, 2009): *Construct validity* reflects the extent to which the operational measures represent the study subject. Our data were quantitative responses from the students, thus representing objective measures. No subjective measures were used, such as data from interviews. *Internal validity* refers to the examination of causal relations. In our study, we primarily focused on descriptive statistics. Our results are preliminary, and further analysis of potential impact factors is needed to build the resulting prediction model. *External validity* concerns how our results could be valid in another case study. The study is empirical and exploratory, and the findings cannot be generalised to an isolated department or university. *Reliability* concerns the extent to which the data and analysis depend on the specific researchers. Again, the data gathered are quantitative and independent of the influence of different research subjects or researchers' interpretations. The survey was administered in a standardised manner during the final session of the course, self-administered and anonymous, ensuring consistent conditions for all participants. Moreover, we acknowledge that more engaged or motivated students might have been overrepresented, possibly leading to a more favourable evaluation of the gamified experience. However, this limitation does not invalidate the findings, especially when the survey participation is high. concerns the extent to which the data and analysis depend on the specific researchers. Again, the data gathered are quantitative and independent of the influence of different research subjects or researchers' interpretations.

5. Results

To answer the RQs, we used a descriptive measurement and calculated the mean value of the responses.

5.1 Perceptions of Gamification in the Course

Regarding RQ1, we investigated how students perceive the use of gamification in the course and, in particular, its impact on their learning, motivation, and engagement. From Table 2, the students showed a positive perception of gamification in the course. In particular, the bonus system seems to motivate the students to participate more actively in the course (Q6, μ=3.74). Moreover, the gamified approach appears to contribute to the overall learning experience of the students (Q10, μ=3.70). However, the results showed that the use of role-

playing did not support the students to better understand the course content (Q5, μ=2.92). The gender of the students and the experience with the use of gamification in education do not seem to be related to the impact on learning, motivation, and engagement of the students.

5.2 Stress and Time Management

Regarding RQ2, we investigated the stress level and time management related to the use of gamification in the course. From Table 2, we can claim that the students experienced moderate stress during the course (Q11, μ=2.54), and especially the role-playing approach added slightly more pressure (Q12, μ=3.00). The gamified activities did not seem to help reduce the stress (Q13, μ=2.84). At the same time, the students felt quite anxious about earning bonus points for achieving higher scores on the final exam (Q14, μ=2.96) or for achieving high scores on the final exam (Q14, μ=2.96). On the contrary, the gamified activities helped to reduce stress by making the learning process more enjoyable (Q13, μ=2.92)

Furthermore, an interesting result from the chi-square test for association showed a strong statistically significant difference between gender and overall stress level due to gamification ($p<0.05$, Cramer's V=0.431). The post hoc test revealed that female students have higher overall stress levels during the course because of gamification rather than their male peers (Adj. residual > 1.96). The students' experience with gamification in education does not seem to be related to stress levels and time management.

5.3 Fairness in Gamification and Grading

Regarding RQ3, we examined the perceived fairness of gamification implementation and the grading process of the students. From Table 2, we can claim that the gamification approach was implemented quite fairly for all the students (Q17, μ=3.52), and the role-playing activities were equally provided among the students (Q18, μ=3.48). Moreover, the students reported that awarding bonus points at the group level was somewhat of a fair approach (Q19, μ=3.18) and the bonus system was applied fairly for all the students (Q20, μ=3.24). However, the students raised some concerns regarding assessing the bonus points from one teacher instead of two jointly (Q21, μ=2.84). Moreover, the students reported that the assessment criteria could have been communicated more transparently and consistently (Q22, μ=2.94). The gender of the students and their experience with the use of gamification in education do not seem to be related to the perceived fairness of gamification implementation.

Table 2: Descriptive results

Perceptions of Gamification in the Course	
Question	**Mean**
Q4	3.66
Q5	2.92
Q6	3.74
Q7	3.28
Q8	3.58
Q9	3.32
Q10	3.70

Stress and Time Management	
Question	**Mean**
Q11	2.54
Q12	3.00
Q13	2.84
Q14	2.96
Q15	2.94
Q16	3.10

Fairness in Gamification and Grading	
Question	**Mean**
Q17	3.52
Q18	3.48
Q19	3.18
Q20	3.24
Q21	2.84
Q22	2.94

6. Discussion and Conclusions

This study aimed to determine students' motivation and engagement to participate in practical Informatics courses developed based on a holistic gamification approach at a Swedish university. Gamification concepts (bonus points, real-life scenarios, and role-playing) were designed and implemented in one of our practical courses, Software Architecture.

The findings from this study showed that students generally perceived the gamification elements in the course as engaging and motivating and positively impacting their learning. The bonus point system, in particular, was viewed positively, encouraging active participation and deeper involvement with the course content. This is consistent with the findings from (Molls and Gao, 2022). In addition, While the overall experience was

favourable, role-playing activities received mixed reactions, with some students finding them less helpful or difficult to relate to. The gamified structure contributed to a more interactive and dynamic learning environment.

Moreover, students reported experiencing moderate stress towards the gamification approach, particularly about performance-based elements such as earning bonus points. While gamification was intended to enhance enjoyment and reduce pressure, it did not significantly alleviate stress for most students. Some students—especially female participants—felt additional pressure linked to role-playing and competitive aspects of the course. Time management was also reported as a challenge, suggesting that while gamification may boost engagement, it requires careful balancing to avoid unintended stress. This aligns with previous findings, which identified time availability as one of the key challenges for students engaging in gamified activities.

Furthermore, students generally perceived the gamification and grading process as fair, particularly appreciating the group-based nature of bonus point allocation and the equal distribution of activities. However, some concerns were raised regarding reliance on a single instructor for grading, implying that involving multiple assessors could enhance the perceived fairness and objectivity of the evaluation process. Additionally, students expressed a desire for more transparent and consistent communication of the assessment criteria.

Our study contributes to the existing literature by applying a holistic gamification approach to an entire practical course rather than isolated activities or modules. This study applied a holistic gamification approach to enhance a practical Informatics course, with Software Architecture as the case example. Furthermore, it also provides empirical insights into how such an integrated design can influence student engagement, motivation, and learning experiences by incorporating a gamified approach throughout the course structure. This adds to the growing body of research emphasising the importance of gamification approaches in higher education.

Several recommendations emerge from this study for teachers seeking to implement gamification in their courses. First, allocating sufficient time for planning and designing the gamified structure is crucial to ensure alignment with learning objectives and fair assessment. Second, clear instructions and transparent criteria are vital to students' satisfaction and perceived fairness. Third, while interactive methods such as role-playing can enhance learning, they should be introduced with care and supported with adequate guidance. Finally, teachers should remain mindful of diverse student experiences, particularly concerning stress and performance anxiety.

The study will be replicated in the near future with a different group of students and a theoretical course to better understand how gamification designs can be applied in various types of courses.

Ethical Declaration

The authors declare they have no competing interests or ethical conflicts to disclose.

AI Declaration

The authors acknowledge the use of artificial intelligence tools for grammar and syntax correction during the preparation of this manuscript. These tools were used solely to enhance the readability and linguistic quality of the text.

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