Flip for not flopping! Evaluating Gamified Flipped Classes in Software Engineering

Necio Veras[1], **Mayara Olivindo**[1], **Windson Viana**[2], **Lincoln Rocha**[2]

[1]Federal Institute of Ceara (IFCE)

necio.veras@ifce.edu.br, mayaraolivindo21@gmail.com

[2]Federal University of Ceara (UFC)

windson@virtual.ufc.br, lincoln@dc.ufc.br

Abstract. *Teaching Software Engineering presents challenges for promote practical skills through hands-on activities. This study reports an experiment combining the Flipped Classroom approach with gamification techniques in SE education. Conducted over eight months in a hybrid teaching setting, the quasi-controlled experiment involved 111 technical and undergraduate students. Two FC models—with and without gamification—were compared based on student perceptions and learning outcomes across 18 lessons. Results indicate that gamification increased motivation and effort, especially among technical students, and enhanced skill development in undergraduates. The findings suggest the model's potential for broader use, including in face-to-face lab-based settings.*

Resumo. *O ensino de Engenharia de Software apresenta desafios para a promoção de habilidades práticas usando atividades "mão na massa". Este estudo relata um experimento que combina a abordagem de Sala de Aula Invertida com técnicas de gamificação no ensino de ES. Realizado ao longo de oito meses em um contexto de ensino híbrido, o experimento quasi-controlado envolveu 111 estudantes dos níveis técnico e superior. Dois modelos de Sala de Aula Invertida — com e sem gamificação — foram comparados com base na percepção dos alunos e nos resultados de aprendizagem ao longo de 18 aulas. Os resultados indicam que a gamificação aumentou a motivação e o esforço, especialmente entre os estudantes do nível técnico, e aprimorou o desenvolvimento de habilidades nos alunos de graduação. As conclusões sugerem o potencial de uso mais amplo do modelo, inclusive em contextos presenciais.*

1. Introduction

Teaching Software Engineering (SE) involves challenges beyond the theoretical understanding of software development principles. Although SE curricula commonly emphasize technical skills—such as requirements engineering, design, construction, and testing—soft skills like communication, collaboration, and critical thinking are often overlooked [González-Morales et al. 2011]. Traditional teacher-centered approaches limit student engagement and hinder the development of such competencies, as students assume a passive role in the classroom [Villegas-Ch et al. 2021, Cheng-lin and Jian-wei 2016].

As a legacy of the COVID-19 pandemic, educational institutions worldwide transitioned from fully in-person instruction to hybrid learning environments

[Bozkurt and Sharma 2020, Hodges et al. 2020]. Initially, many instructors attempted to replicate traditional lectures using web conferencing tools; however, studies reported a decline in student engagement and motivation, exacerbated by challenges in maintaining routines, psychological stress, and limited opportunities for collaboration [Trinta et al. 2020, Maxim et al. 2022, Costa et al. 2021]. These constraints underscored the need for more interactive and student-centered learning approaches.

In this context, hybrid methodologies such as the Flipped Classroom (FC) emerged as promising alternatives. FC reverses the traditional model by assigning content exploration to pre-class activities and dedicating class time to problem-solving and collaborative exercises [Roehl et al. 2013, Bergmann and Sams 2012]. Its structure aligns well with both remote and in-person environments, enabling teachers to leverage digital content and promote active learning [Veras et al. 2020]. To further enhance engagement, FC can be combined with gamification strategies—applying game elements like feedback, rewards, and interaction to educational contexts [Attali and Arieli-Attali 2015, Álvarez et al. 2017]. Previous studies suggest that integrating FC with gamification improves student motivation, performance, and problem-solving in SE education [Herold et al. 2011, Matsumoto et al. 2016, Sailer and Sailer 2021].

This paper presents the results of a quasi-controlled experiment evaluating two FC models—one with gamification and one without—in SE education. Conducted over three semesters with 111 students from technical and undergraduate programs in Brazil, the study analyzed students' perceptions and achievements across 18 flipped lessons. Results indicate that the gamified model significantly increased motivation and effort, especially among technical students, and enhanced skill development in undergraduates. These findings support the application of the proposed model in both remote and in-person learning environments.

2. Background

2.1. Flipped Classroom in Software Engineering

FC is an active learning approach that restructures the traditional lecture-based model by shifting content delivery to pre-class study and focusing class time on interactive and practical activities. While there is no single way to implement FC, the model proposed in [Veras et al. 2020] is commonly referenced. In this model, students first engage with curated materials—videos, texts, podcasts, and quizzes—before class [Araújo et al. 2020], enabling them to participate more effectively during in-class discussions and exercises [Gannod et al. 2008]. The instructor can then focus on deeper cognitive tasks and adapt instruction to diverse student backgrounds [Bergmann and Sams 2012].

FC fosters a learner-centered environment where instructors act as facilitators, guiding collaborative and practical activities such as simulations, debates, and programming exercises [Akçayır and Akçayır 2018]. Studies across various disciplines confirm its applicability and benefits, including increased engagement, autonomy, and the development of higher-order thinking skills [Zhao et al. 2021, Lin et al. 2021]. The best practices are emphasized in [Harris et al. 2016] from both student and teacher perspectives, addressing challenges like resistance, preparation, and engagement. However, effective implementation requires mastering active learning paradigms, planning meaningful tasks, and involving students in the instructional design.

The application of FC in SE teaching has shown promising results. A systematic mapping study reviewed 26 studies from 2008 to 2020 and found that 92.3% reported positive impacts on learning [Veras et al. 2020]. These studies highlighted improvements in motivation, satisfaction, engagement, collaborative learning, and class time optimization. The most common in-class strategies were problem-based learning, project-based learning, and team-based activities. Nonetheless, several challenges persist, including excessive workload for instructors, difficulty in maintaining student motivation, scalability in large classes, and variability in student engagement. For instance, [Erdogmus and Péraire 2017] documented implementation issues in remote settings, particularly related to mentoring and interaction. These findings suggest that while FC is beneficial, its success in SE education depends on context-aware adaptations and the use of supportive tools and methods.

2.2. Gamification in Flipped Classrooms

Gamification involves integrating game elements—such as points, rewards, competition, and narrative—into non-game contexts to increase user engagement and motivation [Attali and Arieli-Attali 2015, Álvarez et al. 2017]. In educational settings, gamification has shown to positively affect student behaviour, learning outcomes, and motivation levels [Hamari et al. 2014, Kiryakova et al. 2014]. The learner's journey is often structured as a progression through tasks, levels, and feedback loops aimed at achieving specific objectives.

Combining FC with gamification can amplify the benefits of both methods. Studies show that integrating game elements into flipped classrooms leads to increased motivation, participation, and improved learning outcomes [Matsumoto et al. 2016, Sailer and Sailer 2021, Ekici 2021]. For instance, [Sailer and Sailer 2021] observed positive effects on motivation and social relatedness, while [Ekici 2021] found that gamified flipped classrooms fostered deeper learning and higher academic achievement. These results suggest that gamification is a valuable complement to FC, particularly in managing student engagement during in-class activities and making pre-class preparation more appealing. Nonetheless, successful implementation depends on factors such as game design, tool selection, and alignment with learning objectives.

2.3. Gamified Flipped Classroom in Software Engineering

Research combining gamification and FC in SE education has explored diverse formats, including LEGO-based activities, analogy games, and serious games for teaching agile methods and teamwork [Herold et al. 2011, Johnson et al. 2016, Matalonga et al. 2017, John and Fertig 2022]. These studies reported improvements in student motivation, interaction, and problem-solving abilities. However, some lacked conclusive evaluation due to limited scope or ongoing implementation [John and Fertig 2022].

This paper expands on previous studies by investigating the impact of gamified flipped classrooms beyond agile methods, including broader SE topics such as quality, modeling, and requirements. Our approach introduces gamification in pre-class materials and compares its effects on student perception and achievement across two educational levels (technical and undergraduate) over an extended period. The study contributes new insights into the design and evaluation of gamified active learning models in SE education.

3. Our Gamified Flipped Classroom Model

3.1. Flipped Classroom Structure

Our FC model was designed in three main stages: (1) pre-class, (2) synchronous class, and (3) post-class. In the pre-class stage, instructors prepare a study guide that includes videos, book chapters, scientific articles, grey literature, and self-assessment quizzes. The study guide is designed to help students reach the initial levels of Bloom's Taxonomy—remembering and understanding—by guiding them to explore the materials before class time [Krathwohl 2002]. Students are expected to follow the guide independently and complete quizzes to assess their comprehension.

During the synchronous class, the instructor focuses on answering frequently asked questions, providing brief explanations, and leading hands-on activities such as quizzes, brainstorming sessions, software design tasks, programming exercises, and project planning. These tasks target higher-order cognitive processes such as applying, analyzing, and creating. Finally, in the post-class phase, students receive review materials prepared by the instructor to consolidate learning and engage in reflective activities aimed at the evaluating level of Bloom's taxonomy. Figure 1 illustrates the relationship between these stages and Bloom's cognitive domains.

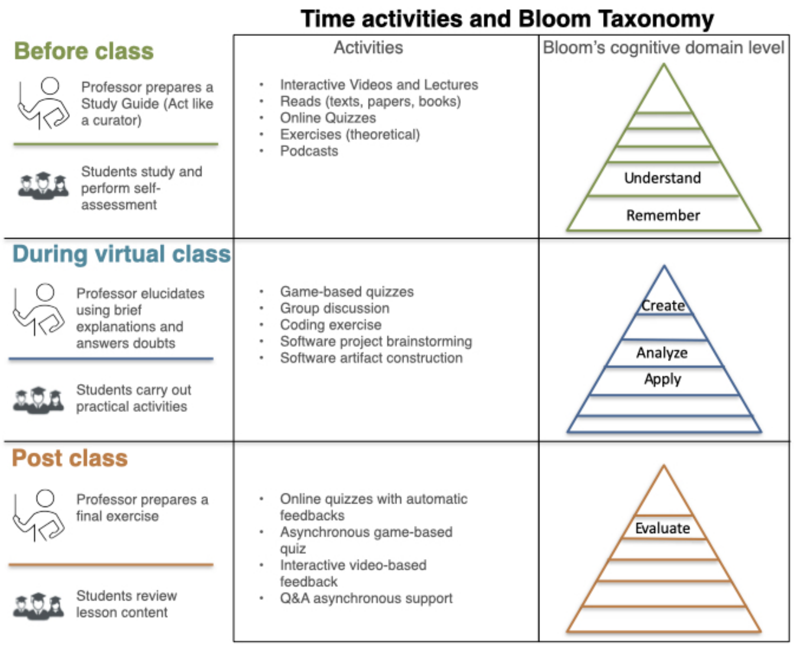

Figure 1. Flipped Classroom activities and Bloom's Taxonomy

3.2. Model Development and Application

Our FC model was developed over four years and refined through application in multiple contexts: Distributed Systems [Araujo et al. 2018, Araujo et al. 2019, Araújo et al. 2020], Computer Networks [Lima and Carvalho 2021], Data Structures [Souza et al. 2022], and Software Engineering (SE) [Olivindo et al. 2021]. The model was implemented through virtual classes using online tools and institutional learning platforms. Instructors modeled the learning path and distributed the assessment links to students via the academic system. The version using the traditional (non-gamified) study guide is referred to as **non-FLGSG**.

3.3. Gamified Study Guide Design

To increase student engagement and acceptance, we developed a gamified version of the FC model using Gamified Study Guides (**FLGSG**). The gamification was implemented using online forms (Google Forms) and framed by a fictional narrative titled *"SE80: Software Engineer in 80 Days"*, inspired by Jules Verne's work [Verne 2013]. In this narrative, the main character—Ada Neuma—travels around the world facing SE-related challenges presented by historical figures such as Napoleon Bonaparte, Alan Turing, and Cleopatra. Each narrative phase corresponds to a flipped lesson on specific SE content and occurs in a different geographical location (see Figure 2).

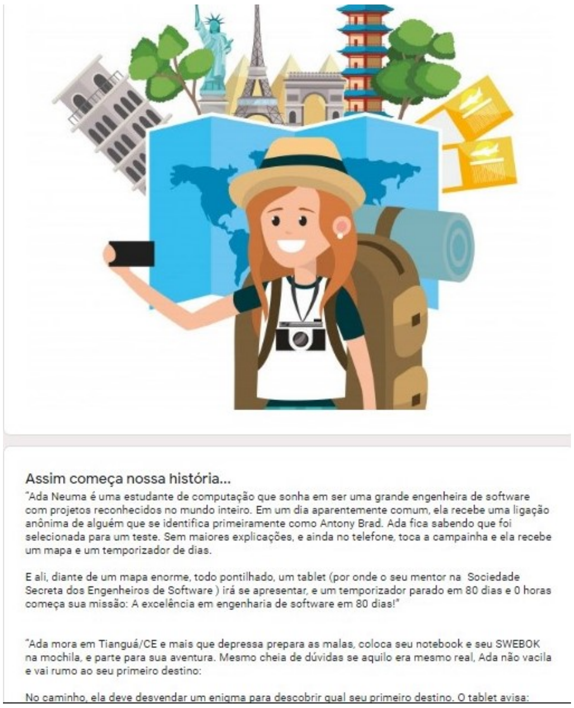

Figure 2. Narrative presentation (in Portuguese)

Figure 3 presents the gamified guide flow. Each phase consists of three milestones: the first includes general questions to test basic comprehension; the second presents more complex, content-specific challenges; and the third features a review stage with true/false questions. Correct answers are rewarded with points and content stamps, while incorrect responses trigger "interventions" that offer additional resources such as videos, podcasts, papers, or book chapters. Dialogues with historical characters guide the interaction and feedback, making the learning process more immersive and engaging.

3.4. Gamification Mechanics and Learning Objectives

The gamification mechanics embedded in the FLGSG include narrative storytelling, progression through milestones, immediate feedback, rewards, and personalized remediation through interventions. These elements aim to promote sustained motivation and autonomous learning. Each phase is structured to gradually advance students through Bloom's cognitive levels—from understanding in the pre-class phase to creating and evaluating during in-class and post-class activities.

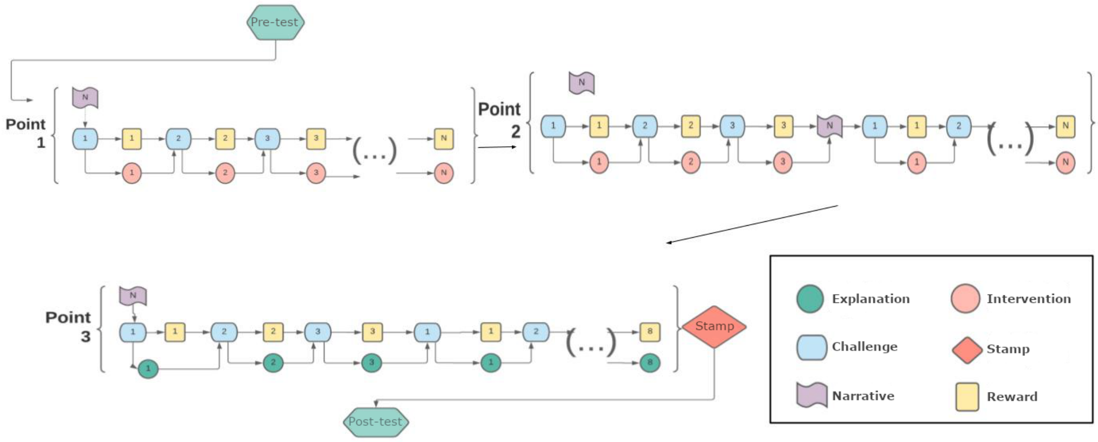

Figure 3. A gamified study guide flow

By embedding gamification into the study guide rather than the classroom session itself, we sought to enhance engagement during the often-overlooked pre-class preparation phase. This approach also facilitates formative assessment, allowing instructors to identify misconceptions early and adapt instruction accordingly. Our model aligns pedagogical objectives with motivational strategies to improve student performance in SE education, especially in hybrid environments.

4. Study Design

We performed a quasi-controlled experimental design to evaluate the effectiveness of a gamified flipped classroom model in SE education. The study was planned and executed based on the experimental guidelines described by [Wohlin et al. 2012] and used in similar educational contexts [Paschoal et al. 2020].

4.1. Objectives and Research Questions

The primary goal was to assess the impact of gamified study guides in flipped classes, focusing on students' perceptions (acceptance, effort, and motivation) and achievements (engagement and learning impact). The research questions (RQ1–RQ5) are summarized in Table 1, and the hypotheses are defined as follows:

- **Null hypothesis** (H_0): The use of gamified study guides (FLGSG) does not lead to higher students' perceptions or achievements compared to non-gamified study guides (non-FLGSG).
- **Alternative hypothesis** (H_a): The use of FLGSG improves students' perceptions and achievements compared to non-FLGSG.

4.2. Participants and Context

The study was conducted over eight months in a hybrid education setting. A total of 111 students from two Brazilian public institutions participated, comprising 75 undergraduate students enrolled in Computer Science programs and 36 high school students from a Technical Informatics program. The experiment addressed six Software Engineering topics—Modeling, Requirements, Process, Design, Quality, and Basic Concepts—delivered through 18 flipped classroom sessions across three academic semesters.

Table 1. Research questions

ID	Question	Rationale
RQ1	To what extent does FLGSG increase learners' acceptance compared to non-FLGSG ?	Assess students' acceptance of the study guide, learning, and difficulty level during the study.
RQ2	To what extent does FLGSG reduce learners' effort compared to non-FLGSG ?	Examine student effort regarding the time spent following the study guide.
RQ3	To what extent does FLGSG promote learners' motivation compared to non-FLGSG ?	Measure students' motivation regarding having other SE flipped classes.
RQ4	To what extent does FLGSG improve learners' engagement in out-of-class activities compared to non-FLGSG ?	Measure the students' engagement related to the study guide use.
RQ5	To what extent does FLGSG increase learners' skills on the score tests compared to non-FLGSG ?	Determine the FC impact on student learning about SE skills.

4.3. Experimental Procedure

We defined two treatments: **Treatment A** (non-FLGSG) used a traditional study guide in PDF format, while **Treatment B** (FLGSG) used a gamified study guide in Google Forms format. Both treatments followed the same flipped learning structure: (1) pre-class preparation using the study guide; (2) synchronous class with Q&A and practical activities; and (3) post-class review exercises. Each flipped class included a pre-test and a post-test to assess knowledge acquisition.

4.4. Variables and Instruments

The dependent variable is **effectiveness**, measured in two dimensions: (1) **Students' Perceptions** — acceptance, effort, and motivation assessed via Likert-scale questionnaires (Table 2); (2) **Students' Achievements** — engagement in activities and performance in post-tests.

The independent variable is the **type of active methodology** used (FLGSG or non-FLGSG). Data collection combined qualitative and quantitative approaches using pre/post-tests, perception questionnaires, in-class activities, and logs from the Google Classroom environment.

Table 2. Instrument (questions) for student's perception assessment

ID	Question	Student Perception
Q1	The study guide guided me in reading and visualizing the proposed concepts and practices	Acceptance
Q2	The organization of material and content sequencing to be studied were clear	Acceptance
Q3	I felt ready for practical class after studying using the study guide	Acceptance
Q4	The flipped class format (study guide + practical activity) boosted my learning	Acceptance
Q5	The effort level and flipped class difficulty were overstated given the Pandemic context	Acceptance
Q6	I learned the content taught satisfactorily	Acceptance
Q7	I think the dedicated time to practical activities (in class) was ...	Effort
Q8	The study guide was too long	Effort
Q9	I need to resort to instructional materials not available on the study guide	Effort
Q10	How much time did you spend following the study guide and viewing the suggested videos?	Effort
Q11	The recommended videos' quality kept me motivated and engaged in watching them until their end	Motivation
Q12	I felt motivated to have other classes with this flipped class format (study guide + practical activity)	Motivation

4.5. Content and Material Preparation

Eight gamified and seven non-gamified study guides were developed, each aligned with specific SE content. In total, 31 out-of-class activities, 15 in-class tasks, and 15 post-class exercises were created [1]. Pre- and post-tests, consisting of ten multiple-choice questions, were used to evaluate learning gains. All materials were delivered through Google Classroom. Students' engagement was assessed based on activity completion, participation, and perceived learning value.

4.6. Execution Steps

The experiment followed six structured steps: (1) preparation and distribution of the study guide; (2) students' independent study; (3) synchronous explanation and Q&A; (4) practical activities during class; (5) post-class review activity; and (6) post-test application. The teacher facilitated all sessions and provided asynchronous support. Students' participation in the study was voluntary, and all signed informed consent forms.

5. Data Analysis and Results

This section presents the results of our quasi-controlled experiment, analyzing data collected on students' perceptions and achievements. We used descriptive statistics and inferential tests (Shapiro-Wilk, Mann-Whitney, and T-tests) to validate our hypotheses.

5.1. Students' Perceptions

Acceptance: Students from both treatments (non-FLGSG and FLGSG) positively evaluated the flipped classroom model. No statistically significant difference was found between treatments in general acceptance (Q1-Q6), except for Q5, where FLGSG students perceived higher effort and difficulty. Particular cases (Software Requirements, Modeling, and Process) showed consistent results with the general analysis. **Effort:** FLGSG students reported a significantly higher perceived effort in Q8 (guide length) and in combined effort dimensions (Q7-Q10), especially among technical students. This indicates that the gamified guide required more dedication, though not necessarily more time (Q10). **Motivation:** Students under FLGSG reported significantly higher motivation in Q12 (desire for more flipped classes). FLGSG also improved video engagement (Q11) for undergraduates and in some specific lessons (e.g., Software Requirements). Table 3 details the results regards student's perceptions.

Table 3. P-values for acceptance, effort, and motivation comparisons between Treatment A and B

Context	Acceptance			Effort			Motivation		
	Q1–Q6	Q5	All Qs	Q7–Q10	Q8	All Qs	Q11	Q12	All Qs
Technical	0.5967	**0.0257**	0.5967	**0.0116**	**0.0001**	**0.0116**	0.5552	**0.0219**	0.1002
Undergraduate	0.9979	0.2213	0.9979	0.3485	**0.0110**	0.3485	**0.0024**	**0.0048**	**0.0004**
Both	0.9959	**0.0224**	0.9959	**0.0354**	**2.637e-05**	**0.0354**	0.0919	**0.0002**	**0.0003**
Software req.	0.9976	0.6398	0.9976	0.2822	0.0648	0.2822	**0.0085**	**0.0044**	**0.0004**
Software mod.	0.2213	**0.0183**	0.2213	**0.0306**	0.1373	**0.0306**	0.5576	**0.0317**	0.0817
Software proc.	0.9242	0.5000	0.9242	0.9214	0.2626	0.9214	0.3118	0.2093	0.1689

Qualitative Feedback. Students praised the gamified guide narrative and structure. Suggestions were mostly about improving content clarity and balancing workload. Neutral and critical feedback highlighted the need for more concise materials and better time management.

[1]Available at https://nupreds.ifce.edu.br/necio/materiais-wei25.pdf

5.2. Students' Achievements

Engagement: Overall engagement was high (86%). Technical students showed significantly higher engagement with FLGSG (94.4% vs. 74.3% in non-FLGSG), validating H_a. No significant differences were found among undergraduates. **Learning Impact:** Both treatments significantly improved learning (pre-test vs. post-test). However, undergraduates using FLGSG had a significantly greater knowledge gain compared to non-FLGSG (gain of 1.97 vs. 0.44, p = 0.0291). No significant differences were observed for technical students or the Software Modeling particular case. Table 4 presents the statistical summary.

Table 4. P-values for engagement and learning impact comparisons between Treatment A and B

Context	Engagement			Learning Impact		
	Out-of-class	In-class	All	Pre/Post (A vs B)	Gain	All
Technical	**0.0393**	0.2320	**0.0394**	**1.033e-07 / 0.0018**	0.7892	–
Undergraduate	0.3527	0.9722	0.9023	0.2129 / **1.107e-05**	**0.0291**	–
Both	0.0584	0.8542	0.4253	**3.363e-07 / 3.01e-07**	0.7352	–
Software req.	0.9039	0.1136	0.5171	–	–	**0.0004**
Software mod.	0.2785	0.2785	0.1886	0.2129 / 0.3014	0.5836	–
Software proc.	0.9744	0.5501	0.9369	–	–	0.1689

Observation 1: FLGSG significantly enhanced motivation (Q12), perceived challenge (Q5), and engagement/learning among specific groups (technical for engagement; undergraduate for learning impact). However, it also required more perceived effort, suggesting a trade-off between engagement and workload.

6. Discussion

6.1. RQ1: Acceptance Comparison

The analysis revealed that students using the FLGSG generally showed similar or slightly lower acceptance levels compared to non-FLGSG users. Statistically significant differences were observed only in Q5, where technical students using FLGSG perceived the study format as more difficult. This suggests a higher cognitive demand induced by gamification. Overall, FLGSG did not increase general acceptance.

Observation 2: Learners studying using FLGSG had a lower or equal acceptance rate than those using non-FLGSG.

6.2. RQ2: Effort Reduction

In terms of effort, FLGSG did not reduce student workload. On the contrary, Q8 results indicate that students perceived the gamified study guide as longer and more demanding. This was consistent across both educational levels. Although other effort-related questions (Q7, Q9, Q10) did not show statistically significant differences, the overall perception was of increased effort in the gamified model.

Observation 3: Learners studying using FLGSG did not reduce their effort levels compared to non-FLGSG.

6.3. RQ3: Motivation Promotion

FLGSG positively influenced student motivation. Students using the gamified model expressed greater willingness to attend future FC sessions and felt more engaged by the multimedia content. Statistically significant differences were found in Q11 and Q12, particularly among undergraduate students.

Observation 4: Learners studying using FLGSG felt more motivated than those using non-FLGSG.

6.4. RQ4: Engagement in Out-of-Class Activities

The FLGSG model improved engagement during out-of-class activities, especially among technical students. While the general difference was not statistically significant, the improvement in engagement among technical students using FLGSG was.

Observation 5: Learners studying using FLGSG improved engagement (not significantly) during out-of-class activities compared to non-FLGSG.

6.5. RQ5: Learners' Skill Improvement

Both treatments resulted in significant learning gains (pre- vs. post-test). However, only undergraduate students using FLGSG exhibited statistically greater knowledge gains compared to their peers in the non-FLGSG group. Among technical students, no significant difference was found between treatments.

Observation 6: Undergraduate learners using FLGSG increased their skills on score tests compared to those using non-FLGSG.

7. Final considerations

The use of gamified study guides during flipped SE lessons in hybrid settings enhances motivation and engagement, particularly for undergraduate students. However, this comes at the cost of perceived higher effort. While gamification did not broadly improve acceptance or reduce workload, it demonstrated a positive impact on learner motivation and knowledge acquisition among more mature students. Future implementations of FC in SE education should consider these trade-offs to optimize both student experience and learning outcomes.

Some potential limitations and threats to validity were identified in this quasi-experimental study, which may influence the interpretation and generalization of the results. Internal validity threats include: (a) the non-random assignment of students to treatment groups; and (b) the dual role of one of the researchers as a course instructor. Construct validity threats involve: (a) the design of the gamified study guides by the researcher without external validation; (b) the similarity of pre-test and post-test questions, which were assessed subjectively; and (c) the possibility that students consulted external reference materials during assessments, despite explicit instructions to avoid doing so. External validity threats are related to: (a) the specific context of hybrid teaching, which may limit the applicability of findings to other educational settings; and (b) potential participant overload due to concurrent academic, professional, or domestic responsibilities.

Acknowledgement: This research was partially funded by CNPQ, under grant number 314425/2021-7.

References

Akçayır, G. and Akçayır, M. (2018). The flipped classroom: A review of its advantages and challenges. *Computers & Education*, 126:334–345.

Álvarez, J. J. M., Ortíz-Colón, A. M., Montoro, M. A., Molina Álvarez, J., AM, O. C., Agreda Montoro, M., et al. (2017). Análisis de la integración de procesos gamificados en educación primaria. *Innovación docente y uso de las TIC en eduación: CD-ROM*, page 12.

Araújo, P., Costa, C., Viana, W., de Lima Veras, N., and Farias, E. J. (2020). Automatic personalisation of study guides in flipped classroom: A case study in a distributed systems course. In *2020 IEEE Frontiers in Education Conference (FIE)*, pages 1–9. IEEE.

Araujo, P., Viana, W., Veras, N., and de Castro Filho, J. A. (2018). Aprendizagem adaptativa em aulas invertidas de sistemas distribuídos: um estudo de caso apoiado no g suite. In *Brazilian Symposium on Computers in Education (Simpósio Brasileiro de Informática na Educação-SBIE)*, volume 29, page 328.

Araujo, P., Viana, W., Veras, N., Farias, E. J., and de Castro Filho, J. A. (2019). Exploring students perceptions and performance in flipped classroom designed with adaptive learning techniques: A study in distributed systems courses. In *Brazilian Symposium on Computers in Education (Simpósio Brasileiro de Informática na Educação-SBIE)*, volume 30, page 219.

Attali, Y. and Arieli-Attali, M. (2015). Gamification in assessment: Do points affect test performance? *Computers & Education*, 83:57–63.

Bergmann, J. and Sams, A. (2012). *Flip your classroom: Reach every student in every class every day*. International society for technology in education.

Bozkurt, A. and Sharma, R. C. (2020). Emergency remote teaching in a time of global crisis due to coronavirus pandemic. *Asian Journal of Distance Education*, 15(1):i–vi.

Cheng-lin, H. and Jian-wei, C. (2016). A target design of a mobile app providing supportive service for flipped classroom. *Journal of Educational and Social Research*, 6(1):27.

Costa, R., Júnior, A. C., and Gadelha, B. (2021). Apoiando a revisão por pares no ensino remoto de modelagem de software. In *Anais do Simpósio Brasileiro de Educação em Computação*, pages 352–361. SBC.

Ekici, M. (2021). A systematic review of the use of gamification in flipped learning. *Education and Information Technologies*, 26(3):3327–3346.

Erdogmus, H. and Péraire, C. (2017). Flipping a graduate-level software engineering foundations course. In *2017 IEEE/ACM 39th International Conference on Software Engineering: Software Engineering Education and Training Track (ICSE-SEET)*, pages 23–32. IEEE.

Gannod, G. C., Burge, J. E., and Helmick, M. T. (2008). Using the inverted classroom to teach software engineering. In *Proceedings of the 30th international conference on Software engineering*, pages 777–786.

González-Morales, D., De Antonio, L. M. M., and García, J. L. R. (2011). Teaching "soft" skills in software engineering. In *2011 ieee global engineering education conference (educon)*, pages 630–637. IEEE.

Hamari, J., Koivisto, J., and Sarsa, H. (2014). Does gamification work?–a literature review of empirical studies on gamification. In *2014 47th Hawaii international conference on system sciences*, pages 3025–3034. Ieee.

Harris, B. F., Harris, J., Reed, L., and Zelihic, M. M. (2016). Flipped classroom: Another tool for your pedagogy tool box. In *Developments in Business Simulation and Experiential Learning: Proceedings of the Annual ABSEL conference*, volume 43.

Herold, M., Bolinger, J., Ramnath, R., Bihari, T., and Ramanathan, J. (2011). Providing end-to-end perspectives in software engineering. In *2011 Frontiers in Education Conference (FIE)*, pages S4B–1. IEEE.

Hodges, C., Moore, S., Lockee, B., Trust, T., Bond, A., et al. (2020). The difference between emergency remote teaching and online learning. *Educause review*, 27:1–12.

John, I. and Fertig, T. (2022). Gamification for software engineering students-an experience report. In *2022 IEEE Global Engineering Education Conference (EDUCON)*, pages 1942–1947. IEEE.

Johnson, P., Port, D., and Hill, E. (2016). An athletic approach to software engineering education. In *2016 IEEE 29th International Conference on Software Engineering Education and Training (CSEET)*, pages 8–17. IEEE.

Kiryakova, G., Angelova, N., and Yordanova, L. (2014). Gamification in education. Proceedings of 9th International Balkan Education and Science Conference.

Krathwohl, D. R. (2002). A revision of bloom's taxonomy: An overview. *Theory into practice*, 41(4):212–218.

Lima, T. and Carvalho, W. (2021). Aulas invertidas e práticas lúdicas no ensino de redes de computadores. In *Anais do Simpósio Brasileiro de Educação em Computação*, pages 211–218, Porto Alegre, RS, Brasil. SBC.

Lin, Y.-N., Hsia, L.-H., and Hwang, G.-J. (2021). Promoting pre-class guidance and in-class reflection: A sqirc-based mobile flipped learning approach to promoting students' billiards skills, strategies, motivation and self-efficacy. *Computers & Education*, 160:104035.

Matalonga, S., Mousqués, G., and Bia, A. (2017). Deploying team-based learning at undergraduate software engineering courses. In *2017 IEEE/ACM 1st International Workshop on Software Engineering Curricula for Millennials (SECM)*, pages 9–15. IEEE.

Matsumoto, T. et al. (2016). The flipped classroom experience of gamified. *Creative Education*, 7(10):1475.

Maxim, B., Limbaugh, T., and Yackley, J. (2022). Socially distant active learning and student engagement in software engineering courses. In *2022 ASEE Annual Conference & Exposition*.

Olivindo, M., Veras, N., Viana, W., Cortés, M., and Rocha, L. (2021). Gamifying flipped classes: An experience report in software engineering remote teaching. In *Brazilian Symposium on Software Engineering*, pages 143–152.

Paschoal, L. N., Oliveira, M. M., Melo, S. M., Barbosa, E. F., and Souza, S. R. (2020). Evaluating the impact of software testing education through the flipped classroom model in deriving test requirements. In *Proceedings of the 34th Brazilian Symposium on Software Engineering*, pages 570–579.

Roehl, A., Reddy, S. L., and Shannon, G. J. (2013). The flipped classroom: An opportunity to engage millennial students through active learning strategies. *Journal of Family & Consumer Sciences*, 105(2):44–49.

Sailer, M. and Sailer, M. (2021). Gamification of in-class activities in flipped classroom lectures. *British Journal of Educational Technology*, 52(1):75–90.

Souza, B., Veras, N., Olivindo, M., Mendes, E., Rocha, L., and Viana, W. (2022). Ensino invertido de estrutura de dados no contexto do ensino remoto emergencial. In *Anais do II Simpósio Brasileiro de Educação em Computação*, pages 77–87, Porto Alegre, RS, Brasil. SBC.

Trinta, F., Rego, P. A., and Viana, W. (2020). Teaching development of distributed software during covid-19: An experience report in brazil. In *Proceedings of the 34th Brazilian Symposium on Software Engineering*, pages 616–625.

Veras, N. L., Rocha, L. S., and Viana, W. (2020). Flipped classroom in software engineering: A systematic mapping study. In *Proceedings of the 34th Brazilian Symposium on Software Engineering*, pages 720–729.

Verne, J. (2013). *Around the World in 80 Days-The 1874 Play*. BearManor Media.

Villegas-Ch, W., García-Ortiz, J., Román-Cañizares, M., and Sánchez-Viteri, S. (2021). Proposal of a remote education model with the integration of an ict architecture to improve learning management. *PeerJ Computer Science*, 7:e781.

Wohlin, C., Runeson, P., Höst, M., Ohlsson, M. C., Regnell, B., and Wesslén, A. (2012). *Experimentation in software engineering*. Springer Science & Business Media.

Zhao, J., Hwang, G.-J., Chang, S.-C., Yang, Q.-f., and Nokkaew, A. (2021). Effects of gamified interactive e-books on students' flipped learning performance, motivation, and meta-cognition tendency in a mathematics course. *Educational Technology Research and Development*, 69(6):3255–3280.