

# Gamification and Self-Determination Theory in Teaching Computational Thinking: An Experience with Quizizz Software

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Received: March 2025

**Abstract.** The introductory programming disciplines, which include the teaching of algorithms and computational logic, have high failure and dropout rates. Developing Computational Thinking in students can contribute to learning programming fundamentals by building algorithmic and problem-solving skills. However, keeping students engaged in training such skills is still a challenge. In this sense, this work proposes an intervention for teaching Computational Thinking in the initial semesters of the Technician in Informatics and Bachelor of Computer Science courses, using gamification as a motivational strategy and the Quizizz software as a gamified platform. To evaluate the results, a mixed-method case study was used to perform a quantitative and qualitative analysis of the data and, subsequently, integrate them. The results obtained were discussed based on the Theory of Self-Determination, indicating that students demonstrated a high level of oriented autonomy and motivation to learn, regardless of the performance obtained.

**Keywords:** computational thinking, gamification, self-determination theory, quizizz.

## 1. Introduction

Computer science teachers generally experience difficulties with students, mainly in relation to the initial subjects of the course, which include algorithms, programming and computer logic (Classe and Castro, 2020). Although these topics are elementary, there is a high failure rate, which can lead to students dropping out of the course or even a high dropout rate (Castro and Siqueira, 2019).

Computational Thinking (CT) has the ability to improve programming teaching by building algorithmic and problem-solving skills (Chang, 2016). In this sense, CT can be worked on in initial classes of Computing courses at all levels of education, as an introduction to programming subjects, improving students' understanding, their motivation and, consequently, their performance (Gomes *et al.*, 2020).

Although teachers are looking for new instructional approaches, keeping students engaged remains one of the major concerns (Lehtonen *et al.*, 2015). Thus, the use of game elements in learning tools is an alternative that has remarkable motivational power in encouraging students to engage with their learning process (Feichas *et al.*, 2021).

This paper proposes an intervention for teaching CT to students on the Bachelor's Degree in Computer Science (BCS) and the Subsequent Technical Course in Computer Science (IT course) at the Federal Institute of Education, Science, and Technology of Ceará, Tianguá campus (Brazil), using gamification as a motivational strategy, through the Quizizz tool. The data obtained using this tool was analyzed and compared through the lens of Self-Determination Theory (Gagné and Deci, 2005).

A level of consensus was observed among the students concerning the achievement of guided autonomy, characterized by individuals taking initiative and finding enjoyment in performing the activities. This result was also found to be unaffected by the students' grade level or their achievement in the activity. Furthermore, an analysis was conducted of the positive and negative aspects highlighted by the students regarding the tool, the gamification elements applied, the activity's organization, and their performance, comparing these to the measured levels of autonomy.

The remainder of this article is structured as follows. Section 2 outlines the theoretical framework, with a focus on CT, gamification strategies in the teaching-learning process, and Self-Determination Theory. In Section 3, related studies are presented and compared. Section 4 outlines the materials and methods used, detailing the design of this research, its objectives, and the definition, implementation, and evaluation of the "CT Challenge" game. Section 5 analyzes and discusses the results obtained, while Section 6 outlines the limitations of this study. In conclusion, Section 7 provides final remarks and discusses intentions for future research.

## 2. Background

### 2.1. Computational Thinking (CT)

Jeannette Wing (2006) defines CT as a method for solving problems, designing systems and understanding human behavior, inspired by concepts from Computer Science. Although a relatively recent concept, it has been considered as one of the fundamental pillars of human intellect, alongside reading, writing and arithmetic (Vicari *et al.*, 2018).

This method includes: (i) formalizing problems into a structure that enables the use of a computer or other tools for their resolution; (ii) logically organizing and analyzing data; (iii) representing data through abstractions such as models and simulations; (iv) automating solutions through algorithms; (v) identifying, analyzing and implementing possible solutions with the aim of achieving the most efficient and effective combination of steps and resources; and (vi) generalizing and modifying the solution to one problem in order to address a wide variety of problems (Avila *et al.*, 2017).

The four main pillars of CT are: Decomposition, Pattern Recognition, Abstraction, and Algorithm (Vicari *et al.*, 2018). Decomposition and Abstraction correspond to the first stage of problem solving; the next step is Algorithm design, which eventually leads to computer programming and then a concrete solution. Therefore, many initiatives include the CT teaching stage even before teaching computer programming to students (Agbo *et al.*, 2019).

CT Education is not exclusive to Computer Science courses. It is currently being applied at all levels of education, including basic education, to encourage young people to pursue Computer Science. In this context, the International Challenge on Informatics and Computational Thinking – widely known as the “Bebras Challenge” – has been created for primary, elementary, and high school students, with an emphasis on CT and Computer Science fundamentals (Dagienė and Stupurienė, 2016). This competition has been running since 2004 and is currently applied in more than 40 countries. It consists of a set of questions whose purpose is to test the level of development of CT skills and core Computer Science concepts, including Decomposition, Pattern Recognition, Abstraction, Algorithm, Evaluation, and Generalization.

In most countries, Bebras questions are classified by age. In the British version, entitled Bebras UK3, the questions are categorized as follows: Kids (6–8 years), Castors (8–10 years), Juniors (10–12 years), Intermediates (12–14 years), Seniors (14–16 years) and Elite (16–18 years). According to Moreno-León *et al.* (2018), this challenge is versatile enough to be applied to any age group and remains one of the most widely utilized tools for developing CT skills in educational settings. In Bebras UK, the questions are divided into three difficulty levels (A, B, and C), with type “A” being the simplest and type “C” representing the most difficult. The difficulty of a question determines how it will be scored in the challenge.

The Bebras Challenge is conducted in schools using both computers and mobile devices and it has become so popular that over 1.5 million students from around the world participate each year, a clear indication of its widespread popularity and student acceptance (Dagienė and Stupurienė, 2016). While Bebras primarily caters to pupils in schools, its tasks have been employed in research involving also older audiences, specifically those aged 16 and above, such as higher education students (Mooney and Lockwood, 2020; Oliveira *et al.*, 2025).

## *2.2. Gamification Strategies in the Teaching and Learning Processes*

With the aim of making teaching more engaging, educational games have been implemented as active learning techniques. These resources boost student involvement by aligning with the learning styles (Classe and Castro, 2020). Learning through games requires the construction of a system in which learners are involved in an abstract challenge, defined by clear rules, while interacting and accepting feedback with measurable results, alongside the presence of emotional reactions (Alves, 2015).

Gamification is defined as the use of game-based mechanics, aesthetics and thinking with the aim of engaging people, promoting learning and solving problems (Kapp,

2013). This concept relies on the notion that games in the learning process not only promote the acquisition of new knowledge but also contribute to the development and application of previously learned information (Kotini and Tzelepi, 2015). The basic aim of using gamification is to increase student motivation by providing more effective, efficient, engaging, lasting and fun experiences (Bozkurt and Durak, 2018).

Gamification is a powerful tool for teaching and learning CT, enabling educators to instruct, motivate, and inspire their students. In education, a frequent use of gamification to promote learning involves integrating tools that provide game elements, such as points, levels, and medals, into learning activities (Kotini and Tzelepi, 2015). Popular commonly used solutions to improve students' CT and programming skills includes Minecraft (Kutay and Oner, 2022), AutoThinking (Hooshyar *et al.*, 2021), Lego Mindstorms (Ching and Hsu, 2024), ENGAGE (Park *et al.*, 2020), CodeCombat (Choi and Choi, 2024), Kodetu (Israel-Fishelson *et al.*, 2021), Penguin Go (Zhao *et al.*, 2019), to name some of them (Rao and Bhagat, 2024; Gundersen and Lampropoulos, 2025).

The use of tools like Kahoot! or Quizizz also serve as examples of such solutions (Fonseca *et al.*, 2023). These interactive softwares incorporate elements of game design to engage students in learning both inside and outside the classroom. From fostering intrinsic motivation and autonomy to promoting collaborative learning, Quizizz offers multifaceted benefits such as higher involvement and motivation with better student learning results as consequence (Nurfadila and Hajar, 2024).

In these tools, the game is designed to allow multiple players and features a quiz format, mainly composed of multiple-choice questions, with automatic corrections providing immediate feedback (Madureira and Schneider, 2021). Because of these features, these softwares are frequently used for formative assessments and as a motivational tool for learning content across different disciplines and educational stages (Dantas and Lima, 2019).

In Quizizz, when a teacher creates a game, he can opt for "live game" mode, in which all students join the activity at the same time by entering a code provided by the platform. In this mode, the teacher assumes the role of a game-show host, and the students act as players competing against each other (Wang, 2015). Upon completion of each activity on Quizizz, the tool generates a detailed report for the teacher, displaying how each question was answered, the percentage of correct answers for each question, and the response time for each student.

In particular, through the prism of Self-Determination Theory, Quizizz is seen as an effective gamified environment that supports the learners' needs for autonomy, competence, and relatedness by allowing them to make choices, providing instant feedback on their performance, and building a sense of community (Dayag, 2025).

### 2.3. *Self-Determination Theory (SDT)*

Self-determination refers to a set of behaviors and skills that enable a person to act as the causal agent in shaping their future, thereby fostering psychological well-being.

To be considered self-determined, a behavior must fulfill four core premises: autonomy, self-regulation, psychological empowerment, and self-realization (Appel *et al.*, 2010).

Self-Determination Theory (SDT) examines how people satisfy their motivational needs through different activities, and how these experiences result in moments of well-being or frustration, spanning from intrinsic (or autonomous) motivation to complete amotivation (Gagné and Deci, 2005). Additionally, SDT describes the individual differences in each person's orientation towards the motivational forces that drive their behaviour (Cavenaghi, 2009).

Thus, an individual can have an autonomy orientation, being motivated primarily by intrinsic regulation and autonomous forms of extrinsic motivation; or they may have a control orientation, driven mainly by external and introjected regulation, with a focus on rewards and environmental pressures (Cavenaghi, 2009). The way a person reacts to motivational forces depends on how autonomy and control mechanisms are applied. Individuals who are constantly motivated and well-supported will exhibit greater curiosity and a stronger desire for answers, while those who are heavily controlled may lose this stimulus (Callegari, 2021).

According to SDT, there are the following regulatory processes – also called dimensions – of individuals (Cavenaghi, 2009):

- (i) **Non-regulation:** leads to disorganised, impulsive or passive behaviour, with the achievement of unsatisfactory results for the person, and may be associated with feelings of depression and/or frustration;
- (ii) **External regulation:** behaviour is controlled by specific external contingencies, it is the type of motivation in which the student engages in classroom activities to obtain a reward or avoid punishment;
- (iii) **Introjected regulation:** involves action through an internalised regulation that is not personally accepted, i.e. students are internally controlled to do what should be done in order to maintain self-esteem (affirming their self-worth) or to mitigate a threat to it (avoiding guilt);
- (iv) **Identified regulation:** The individual sees value and importance in the external regulation and unconsciously transforms it into a personally accepted internal regulation, so that the learner does the activity because they know it is important for them to learn;
- (v) **Integrated regulation:** When the regulations are integrated, the person has fully accepted them, in a coherent and harmonious way with other aspects of their identity and values, so that the student sees the activity as important for their learning, integrates it within themselves, values it and accepts it as their own; and finally,
- (vi) **Intrinsic regulation:** innate motivation, it arises spontaneously from psychological needs and manifests itself in an interest in the activity itself, whether for satisfaction, fulfilment or pleasure in doing the activity.

According to Appel *et al.* (2010), there are three types of regulatory style that show how self-determined a person is: (i) Impersonal Orientation; (ii) Control Oriented and (iii) Autonomy Oriented. These styles are shown in more detail in Fig. 1.

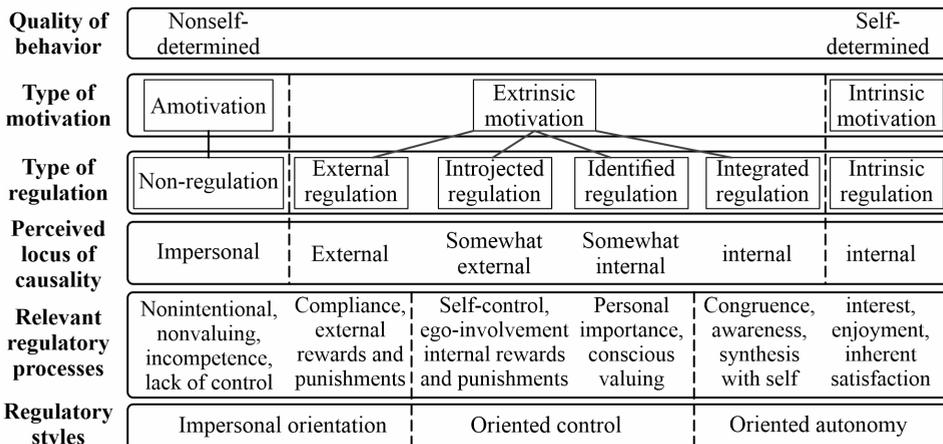


Fig. 1. Regulatory Styles Continuum, adapted from Appel et al. (2010).

Impersonal Orientation is marked by a lack of intentionality, leading to amotivation and non-regulation, often causing anxiety, frustration, and feelings of ineffectiveness. In Oriented Control, an external regulator is in place, the rate of self-determination is minimal, and the motivation for task completion is associated with financial incentives, self-image and social acceptance. Oriented Control is considered to be a characteristic of External or Injected Regulation. Finally, in Oriented Autonomy, individuals exhibit behaviours that align with the principles of Integrated Regulation or Intrinsic Regulation, characterised by the pursuit of personal challenges and the attainment of personal satisfaction, guided by a clearly defined goal. These individuals demonstrate a strong sense of responsibility for their actions, and more generally, they tend to exhibit positive mental health and psychological well-being (Appel et al., 2010).

SDT is a theoretical framework that has been employed in the field of gamification studies (Bozkurt and Durak, 2018). The integration of gaming activities in educational settings has the potential to stimulate creativity, thereby enhancing students’ intrinsic motivation. Additionally, these activities can provide a sense of enjoyment and challenge, leading to a renewed sense of well-being. Consequently, when designed effectively, games can elicit feelings of autonomy, belonging, and competence (Marins, 2013).

### 3. Related Work

Previous studies have explored the use of gamification and games in the teaching-learning process, particularly in teaching CT skills. These works also evaluate the motivating influence of such interventions through the lens of SDT, considering whether the study applies to introductory programming courses. Additionally, the use of gamified platforms such as Kahoot! and Quizizz has been examined, with attention to the teaching modality and target audience.

Hooshyar *et al.* (2021) (ST. 1) introduced an adaptive educational computer game, AutoThinking, aimed at developing CT skills in elementary school students. An experimental study was conducted to evaluate its effects, with one group using AutoThinking and another following a traditional learning method. The findings indicated that students who used AutoThinking showed a significant improvement in CT skills, along with higher levels of interest and satisfaction.

Shi *et al.* (2014) (ST. 2) propose a set of gamification strategies that integrate SDT to boost intrinsic motivation in social e-learning environments at universities. To validate their approach, the authors present a social e-learning platform that implements these strategies, followed by a case study showing an increase in students' perceived intrinsic motivation.

Vahldick *et al.* (2016) (ST. 3) introduced CT to students in introductory undergraduate programming courses through a serious casual game, which featured brief and fast-paced missions that proved effective for out-of-class activities. According to the course instructors, students were able to quickly connect the in-class content with the concepts explored in the game, exhibiting increased confidence and self-esteem.

Callegari (2021) (ST. 4) examined the motivating impact of games from an SDT perspective, using the Kahoot! platform in high school chemistry classes. The results indicated that the game enhanced students' autonomy, serving as a strong motivator. The study also highlighted that favourable outcomes depend on careful pedagogical planning and pointed out that factors like feedback, ranking, and excessive competitiveness could pose challenges. Given these considerations, Kahoot! was found to be a potentially effective motivational tool.

Classe and Castro (2020) (ST. 5) proposed the use of playful lessons – incorporating educational games, gamification, and games – to engage students in the teaching-learning process. The goal was to reduce the failure and drop-out rates in a Fundamentals of Computing course within the Internet Systems and Systems Analysis and Development programs at a Brazilian university. Data on students' perceptions were collected over four semesters, revealing a significant reduction in the failure rate. Additionally, the majority of students expressed satisfaction with both the course delivery and the teaching methods.

Gomes *et al.* (2020) (ST. 6) investigated how gamification can enhance the teaching and learning of Computing for high school students and students in technical courses integrated into high school who had no prior knowledge of the subject. The approach involved incorporating digital games into the classroom to examine how they assist students in constructing mental models of fundamental CT concepts. The mental models formed after the intervention were assessed through evaluations and observations of student discussions during lessons. The study concluded that gamification is an effective strategy for supporting the development of CT skills.

Madureira and Schneider (2021) (ST. 7) investigated the adoption of gamification through games on the Kahoot! platform to encourage students to learn computer programming in first-year Integrated Technical Education classes at a Federal Institute during emergency remote teaching. Conducted through qualitative research, the results showed that gamification enhanced students' motivation to revise content, while also providing a playful way to assess learning. Table 1 summarizes the characteristics of each work mentioned.

Table 1  
Related works

	ST. 1	ST. 2	ST. 3	ST. 4	ST. 5	ST. 6	ST. 7
Use of gamification and/or educational games	✓	✓	✓	✓	✓	✓	✓
CT skills teaching	✓		✓			✓	
Motivational influence of SDT		✓		✓			
Context of introductory programming courses			✓		✓		✓
Use of gamified platforms such as Kahoot! or Quizizz				✓			✓
In-person teaching	✓		✓	✓	✓	✓	
Technical and/or Higher Education		✓	✓		✓	✓	✓

## 4. Materials and Methods

### 4.1. Research Design

This study was conducted as applied exploratory research, employing a mixed-methods approach with both qualitative and quantitative elements, and a cross-sectional design. The methodology followed a case study approach (Yin, 2009), with data collected using the questionnaire in Section 4.4, which served as the instrument for both quantitative and qualitative data. Additional quantitative data were gathered from each student's grade and score, which were obtained through the Quizizz tool.

We adopted a convergent mixed methods design (Creswell and Clark, 2017), specifically employing a mixed-methods case study approach (Guetterman and Fetters, 2018). In this design, quantitative and qualitative data are collected simultaneously but analysed independently. The findings are then integrated, compared, and synthesized to provide a comprehensive understanding (Creswell and Clark, 2017), as in Fig. 2.

The choice of a mixed-methods research design is justified by the complexity and nuances involved in evaluating students' perceptions of gamified strategies and their self-determination to learn CT. Neither a purely quantitative nor a purely qualitative approach alone could adequately capture the multifaceted nature of these dynamics, making a combined approach essential for a deeper and more holistic understanding.

The numerical data collected through the questionnaire and the Quizizz tool were tabulated and analyzed using MS Excel 2010® and JASP 0.16.3.07 software. Descrip-

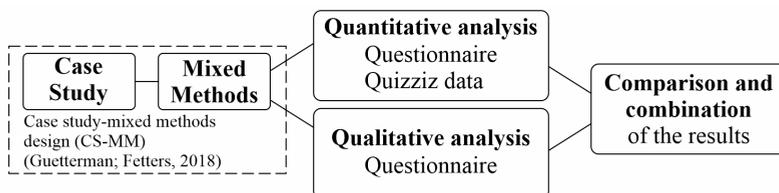


Fig. 2. Design methodology, adapted from Guetterman and Fetters (2018).

tive statistics were applied to summarize and quantitatively describe the dataset. The Kolmogorov-Smirnov test was employed to assess whether the numerical variables adhered to a normal distribution. Measures of central tendency and variability included the mean and standard deviation for normally distributed variables, while the median and interquartile range were used for variables that did not follow a normal distribution. To analyze correlations, Pearson's correlation coefficient was applied for variables with a normal distribution, and Spearman's correlation test was used for non-normally distributed variables (Mallery, 2003).

The qualitative data was obtained from the open-ended questions in the questionnaire presented in Section 4.4. All textual data were imported into MAXQDA, a **qualitative** analysis software, for systematic examination. Using the Thematic Text Analysis approach (Kuckartz, 2014), the data were reviewed multiple times to code and develop overarching thematic categories. The primary focus of this analysis was to identify the positive and negative aspects of adopting gamified tools, such as Quizizz, in the CT teaching process. A secondary focus was to explore students' self-assessments of the CT skills they practiced. Both focuses were evaluative in nature, aiming to determine what aspects were effective and which required improvement.

The methodological framework of this research consists of the following steps: (i) defining the study objectives and research questions (Section 4.2); (ii) designing the "CT Challenge" game (Section 4.3); (iii) developing the questionnaire to assess potential motivational regulations, based on AT (Section 4.4); (iv) implementing the "CT Challenge" game (Section 4.5); and (v) analyzing and discussing the results (Section 5).

## 4.2. Research Objectives

This research aims to evaluate, through the lens of AT, the adoption of a gamified strategy in the CT teaching process using the Quizizz tool in BCS and IT courses, from the students' perspective. To achieve this goal, the study was guided by a central research question: "**How do students evaluate the adoption of gamified strategies, using the Quizizz tool, in the CT teaching process?**" The following sub-questions further structured the investigation:

### (i) Quantitative method:

- **RQ1:** How do students rate the use of gamified tools, such as Quizizz, for teaching CT in terms of self-determination and perceived levels of autonomy?
- **RQ2:** What is the relationship between students' results obtained through the application of gamified tools, such as Quizizz, for teaching CT and the levels of agreement with the Autonomy-Oriented regulatory style?

### (ii) Qualitative method:

- **RQ3:** What are the perceived positive and negative aspects of adopting gamified tools, such as Quizizz, in the CT teaching process?
- **RQ4:** According to the students, how do they evaluate themselves, and what reflections do they have regarding the CT skills they practiced?

**(iii) Mixed method:**

- **RQ5:** What results emerge from comparing the findings obtained through the quantitative method, which assessed students' self-determination, with the qualitative method, which captured their opinions of the activity?

**4.3. CT Challenge Game Definition**

To show the questions and create an engaging, interactive activity, the Quizizz tool was used. It was chosen for its ability to run activities in "live game" mode, offering a game-show-style experience that fosters student participation. Furthermore, its participant capacity was suitable for the intended group size, ensuring effective implementation.

The game featured ten questions selected from the Bebras UK challenges of 2014 and 2016, with a total score of 100 points. These questions incorporated one or more computational thinking (CT) skills and Computer Science concepts, such as Decomposition (DE), Pattern Recognition (RP), Abstraction (AB), Algorithm (AL), Evaluation (AV), and Generalization (GE).

Each question had a time limit based on its complexity. The questions were arranged in increasing levels of difficulty, determined by the age classification: "K" for Kids (6–8 years), "Ca" for Castors (8–10 years), "J" for Juniors (10–12 years), "I" for Intermediates (12–14 years), "S" for Seniors (14–16 years), and "E" for Elite (16–18 years). Within each classification, questions were categorized by difficulty level: "A" for easy, "B" for medium, and "C" for difficult, as shown in Table 2. An example of a question from this challenge, from the students' perspective, is displayed in Fig. 3.

At the end of each question, students immediately receive their results, including the points earned for each correct answer and their position in the ranking. Before proceeding to the next question, the instructor provides a brief explanation of the logic required to solve the question, encouraging a discussion where students can share their approaches,

Table 2  
CT Challenge questions

Id	Question Identification and Year	Skills Addressed	Complexity	Points	Time (min)
01	Broken Window, 2016	AB, AV	K: A; Ca: A	5	5
02	Watering, 2014	AL	K: A; Ca: A; J: A	6	5
03	Bottles, 2016	AB, AV	K: C; Ca: B; J: A	6	5
04	Mazes, 2016	AL	J: A	8	10
05	Abacus, 2014	AB, DE, AL	J: B; I: A	8	10
06	Secret Recipe, 2016	AL, DE, RP	Ca: C; J: B	10	10
07	Party Banner, 2016	AB, AV, GE, RP	Ca: C; J: B; I: A	10	10
08	Space Maze, 2014	AL	S: A; E: A	12	15
09	Beavers on the run, 2014	AB, DE, AL	I: C; S: B; E: A	15	15
10	Broken machines, 2014	AB, AL, AV	S: B; E: B	20	15
				100	100

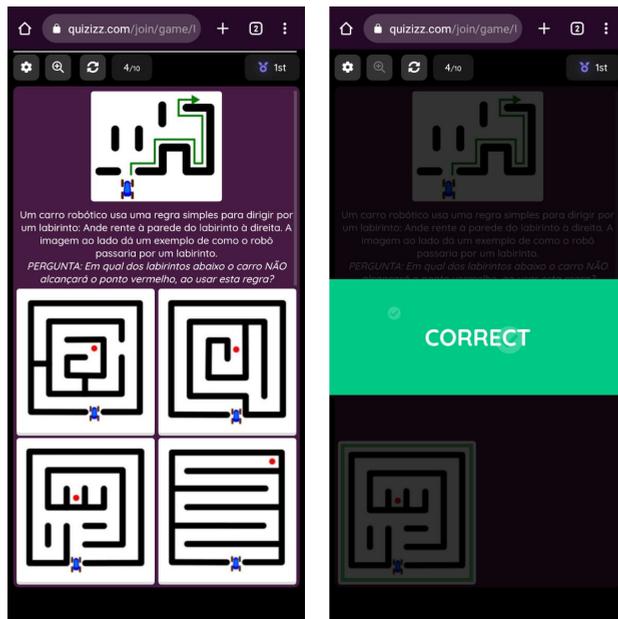


Fig. 3. Challenge question on the smartphone, from the student's point of view.

insights, and identify what went well or what could be improved. Once the activity is complete, the final ranking is displayed for all participants. All questions, except for one (Question 05), are multiple-choice.

#### 4.4. Game Review

Questionnaires and surveys are widely used instruments for assessing knowledge and identifying attitudes towards CT (Shute *et al.*, 2017). For this reason, a questionnaire evaluating the activity was administered at the end of the game using the Google Forms tool. The questionnaire, available online, included questions about students' experiences participating in the game with the gamified tool. Through this self-assessment, it was possible to gauge the students' motivation levels resulting from the use of Quizizz.

To assess students' self-determination, the instrument described by Callegari (2021) was incorporated into the questionnaire. This instrument consists of five-point Likert-type questions (Likert, 1932) with the following response options: "Strongly Disagree", "Partially Disagree", "Indifferent", "Partially Agree", and "Strongly Agree". The questions aim to measure various motivational regulations based on SDT. Specifically, the instrument evaluates the following dimensions: Tool Knowledge, Amotivation, External Regulation, Introjected Regulation, Identified Regulation, Integrated Regulation, Intrinsic Regulation, and Tool Evaluation (Callegari, 2021).

Table 3 presents the structure of the questionnaire, which is organized into three sections and consists of 34 questions, labeled Q1 to Q34 with unique identifiers. The first

Table 3  
Questionnaire Structure

Section	Id	Question
Participant data	Q1	Full Name (Open Response)
	Q2	Gender [Male/Female/Other (Open Response)]
	Q3	Course [BCS/IT]
	Q4	Academic Term [1 to 9]
<b>Self-Determination Assessment (Likert Scale)</b>		
Prior knowledge of the tool	Q5	“Games like Quizizz have already been used by other teachers at my current school.”
	Q6	“I had never played on platforms like Quizizz before.”
Amotivation	Q7	“Using Quizizz in this activity was indifferent to me and did not help me at all.”
	Q8	“I am not interested in using the game during my classes.”
	Q9	“Playing Quizizz was a waste of time.”
External Regulation	Q10	“I only played Quizizz because the teachers asked me to.”
	Q11	“I played Quizizz only because my other classmates did as well.”
	Q12	“I played Quizizz hoping to receive some kind of extra benefit.”
Introjected Regulation	Q13	“I played Quizizz to test my intelligence.”
	Q14	“I played Quizizz just to try to do well in the activities.”
	Q15	“I participated in the Quizizz activity because I don’t feel good if I leave a task undone.”
Identified Regulation	Q16	“I think games can help me get good grades.”
	Q17	“I think the activities with Quizizz would only be useful to help pass the year if they were used in a subject.”
	Q18	“The activity with Quizizz would serve as a way to review content.”
Integrated Regulation	Q19	“I participated in the Quizizz activity because it helped improve my knowledge.”
	Q20	“I played Quizizz because it was a challenge/innovation.”
	Q21	“By playing Quizizz, I became more curious to learn the subject.”
Intrinsic Regulation	Q22	“I participate in games like Quizizz because I feel complete satisfaction during the activities.”
	Q23	“I enjoy activities with games because I can discover new things.”
	Q24	“Activities like Quizizz fully engage me with the content being covered.”
Evaluation of Quizizz	Q25	“The time provided to answer the questions allowed for a challenge and stimulated my learning.”
	Q26	“Knowing in real time whether I got the question right or not motivates me to search for the correct answers.”
	Q27	“The statements were clear enough for me to complete the activities.”
	Q28	“The questions were at an appropriate level for the content covered.”
	Q29	“With the ranking, I feel motivated to participate more and challenge myself.”
	Q30	“My interest in the subject grew with the use of Quizizz.”
Activity Evaluation	Q31	What were the positive aspects of this activity? What did you like the most?
	Q32	What were the negative aspects of this activity?
	Q33	Please indicate your suggestions for improving this activity.
	Q34	Comment on your performance in this activity.

section, “Participant Data”, includes questions related to the students’ demographics. The second section, “Self-Determination Assessment”, is designed to assess students’ possible motivational regulations, as outlined by Callegari (2021). In this section, questions Q5 and Q6 evaluate prior understanding of the tool; Q7 to Q9 measure amotivation; Q10 to Q12 assess External Regulation; Q13 to Q15 examine Introjected Regulation; Q16 to Q18 focus on Identified Regulation; Q19 to Q21 address Integrated Regulation; Q22 to Q24 gauge Intrinsic Regulation; and finally, Q25 to Q30 are concerned with the evaluation of Quizizz. The third section, “Activity Assessment”, asks students to reflect on their perception of the activity, with the opportunity to provide freely informed responses to open-ended questions.

The questions in the “Self-Determination Assessment” section were analyzed quantitatively, while the responses to the open-ended questions in the “Activity Assessment” section were analyzed qualitatively (Section 5).

#### *4.5. CT Challenge Game Application*

The CT Challenge game was conducted as part of the academic activities scheduled for a teaching-focused Saturday during the 2022.2 semester, targeting the Bachelor of Computer Science (BCS) and IT courses at Federal Institute of Education, Science, and Technology of Ceará, Tianguá campus (Brazil). The event took place on the morning of August 27, 2022, lasting three hours and involving 61 students from both programs (Fig. 4).

There were no programming skill prerequisites, allowing any student from either course to participate. However, the activity was primarily aimed at students in the early semesters. Participants were granted attendance for their course subjects and received a certificate of participation to count towards their complementary activity hours.

A brief presentation was given before the activity to introduce the concept of Computational Thinking (CT) and explain how Quizizz works. Students were then provided with a unique code to access the quiz created for the game. After entering the code, they input their names on their smartphones, and the application automatically assigned each participant an avatar. The game was conducted in “live game” mode, with the instructor controlling the pace. This ensured that all students began each question simultaneously. Points were awarded for correct answers, with additional bonuses for faster responses. Results were revealed only after the timer for each question had expired.

At the end of the activity, students were asked to complete the questionnaire described in Section 4.4. All 61 participants agreed to take part in the research and authorized the use of their images for publicity and research reporting purposes. Before completing the questionnaire, students were presented with an Informed Consent Form (ICF), which clarified that participation was voluntary, their responses would not influence their grades in any subject, and their anonymity would be maintained.

The characteristics of the participants in the “CT Challenge” game are shown in Table 4, in which the demographic variables are described in terms of absolute frequency (n) and relative frequency (%). The majority of subjects (62.3%) were male, 67.21% of all participants were studying at BCS and the majority of students were in the first semester of their respective courses (34.15% for BCS and 95% for IT).



Fig. 4. “CT Challenge” game participants.

Table 4

(a) Demographic characteristics of the participants ( $n = 61$ ) in terms of gender and course, and (b) regarding the current semester

(a)	n	%	(b)	Course	Semester	n	%
<b>Gender</b>				BCS	1	14	34,15
Female	23	37,71			2	9	21,94
Male	38	62,30			3	8	19,51
<b>Total</b>	<b>61</b>	<b>100,00</b>			4	1	2,44
<b>Course</b>					6	5	12,20
BCS	41	67,21			9	4	9,76
IT	20	32,79	<b>Total</b>			<b>41</b>	<b>100,00</b>
<b>Total</b>	<b>61</b>	<b>100,00</b>	IT	1	19	95,00	
				4	1	5,00	
			<b>Total</b>			<b>20</b>	<b>100,00</b>

## 5. Results and Discussion

The questionnaire in Section 4.4 gathered data on students' prior understanding of the tool, as well as their assessment of the activity and self-determination. While the items related to regulatory styles (Q7 to Q24) had been previously validated for internal consistency (Callegari, 2021), some questions were adapted to better align with the game. As a result, a new reliability analysis was conducted using Cronbach's alpha ( $\alpha$ ) coefficient (Cronbach, 1949). The results of this analysis indicated  $\alpha = 0.84$ , which is considered "good" internal consistency according to Mallery's classification (2003). When the coefficient value exceeds 0.7, the measures are regarded as reliable (Vieira, 2018). With this confirmation of reliability, the quantitative, qualitative, and mixed-methods analyses of the intervention proceeded, as outlined in the following subsections.

### 5.1. Quantitative Analysis

The "Understanding of the tool" section of the questionnaire aimed to assess whether the students were familiar with the Quizizz software. The results, shown in Fig. 5, indicate that the class was split on whether they had experienced teachers using games like Quizizz before (Q5, "Games like Quizizz have already been used by other teachers at my current school"), with approximately 47.54% agreeing and the same percentage disagreeing. This finding is consistent with the response to statement Q6 ("I had never played on platforms like Quizizz before"), where 42.62% of students stated they had never played games on such platforms. This reinforces the point made by Orlandi *et al.* (2018), who highlight that gamification as a teaching method is still a relatively new concept and part of the ongoing evolution of educational strategies.

The students' motivation and degree of self-determination were assessed based on the continuum of regulatory styles outlined in Section 2.3. The questionnaire used aimed to evaluate the six dimensions involved: Amotivation, External Regulation, Introjected Regulation, Identified Regulation, Integrated Regulation, and Intrinsic Regulation. The results allow us to answer RQ1 ("How do students rate the use of gamified tools, such as Quizizz, for teaching CT in terms of self-determination and perceived levels of autonomy?") as follows.

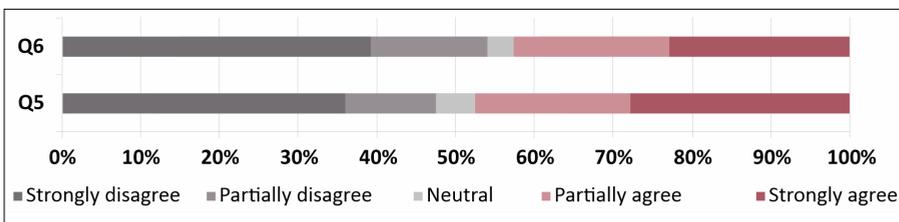


Fig. 5. Questions about prior knowledge of the Quizizz tool.

The dimensions related to Impersonal Orientation were addressed first: Amotivation (Q7 to Q9) and External Regulation (Q10 to Q12), as shown in Fig. 6. In the Amotivation dimension, most students disagreed with the statements. For example, 83.61% disagreed with the statement that Quizizz didn't help at all (Q7, "Using Quizizz in this activity was indifferent to me and did not help me at all"). A similarly high percentage (88.52%) disagreed with the statements in Q8 ("I am not interested in using the game during my classes") and Q9 ("Playing Quizizz was a waste of time"), which suggested that they were uninterested in games in class or viewed games as a waste of time. Since amotivation reflects a lack of engagement or perceived value, it was clear that this applied to only a small minority of the participants. Consequently, it was found that the game had little to no amotivating impact on the students.

The External Regulation dimension of Impersonal Orientation reflects a low level of extrinsic motivation, where participation in an activity is driven by the perception of a potential punishment for non-participation or a reward for participation. The results indicate that, in both questions Q10 ("I only played Quizizz because the teachers asked me to") and Q11 ("I played Quizizz only because my other classmates did as well."), the majority (88.89%) of students reported engaging in the Quizizz activities because they were instructed to or because their classmates were also participating. However, in response to statement Q12 ("I played Quizizz hoping to receive some kind of extra benefit"), while the majority (75.41%) disagreed with the notion that they played the game in expectation of some external benefit, 9.84% of students agreed that they played in hopes of receiving rewards. This suggests that, for a small portion of participants, extrinsic motivation was a factor in their involvement.

Moving on the continuum of regulatory styles, we evaluated the dimensions related to Oriented Control: Introjected Regulation (Q13 to Q15) and Identified Regulation (Q16 to Q18), as shown in Fig. 7. In the case of Introjected Regulation, the focus is on how individuals behave in relation to external expectations, specifically whether they engage in activities to maintain their self-esteem or avoid feelings of guilt. With the exception of statement Q13 ("I played Quizizz to test my intelligence"), where the majority (72.13%) viewed Quizizz as an intelligence test – indicating an effort to maintain self-esteem – the trend in the other responses was one of disagreement or indifference. For instance, 22.95% of students agreed that they played Quizizz mainly to perform well in the activities (Q14, "I played Quizizz just to try to do well in the activities"), and 37.7% indicated that they didn't feel good when they failed to complete the assigned tasks (Q15, "I participated in the Quizizz activity because I don't feel good if I leave a task undone").

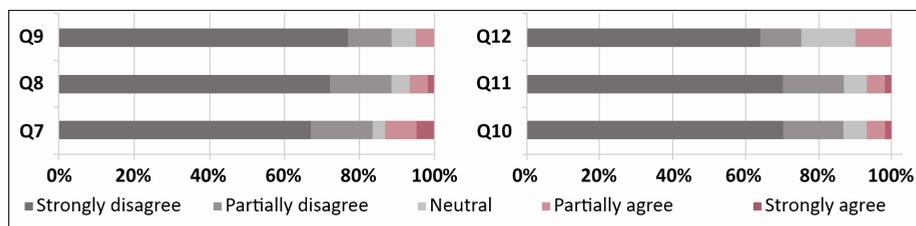


Fig. 6. Impersonal Orientation Questions.

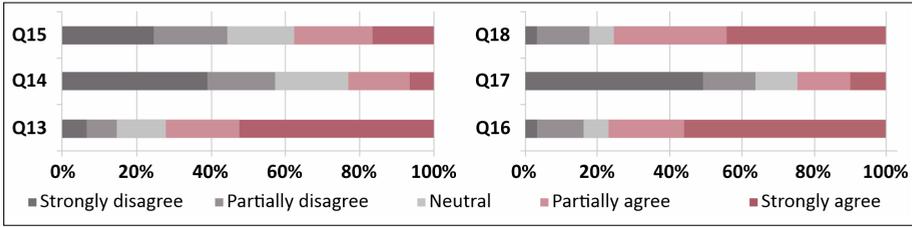


Fig. 7. Guided Control issues.

In the Identified Regulation dimension of Oriented Control, the tendency to disagree with extrinsic motivations begins to shift. This dimension reflects the individual’s understanding and recognition of the value of the proposed task. Students engage in the activity because they see it as important for their learning. The majority of students (77.05%) believe that the games help them achieve good grades (Q16, “I think games can help me get good grades”), and 75.41% view the games as a means of reviewing content (Q18, “The activity with Quizizz would serve as a way to review content”), indicating that they recognize the educational purpose behind the use of the game. However, in statement Q17 (“I think the activities with Quizizz would only be useful to help pass the year if they were used in a subject”), most students (63.93%) disagreed with the idea that activities like Quizizz would only help them pass the year, further demonstrating their deeper understanding of the learning benefits of the activity.

The dimensions related to Guided Autonomy were then assessed: Integrated Regulation (Q19 to Q21) and Intrinsic Regulation (Q22 to Q24), as shown in Fig. 8. A stronger consensus emerged in relation to Integrated Regulation, which reflects the alignment of activities with personal values and desires. The game, in this case, resonated strongly with students’ intrinsic motivations. A notable 83.61% of students reported that the game prompted them to pursue a deeper understanding of the subjects (Q19, “I participated in the Quizizz activity because it helped improve my knowledge”). Furthermore, 86.89% regarded the game as both a challenge and an innovative approach (Q20, “I played Quizizz because it was a challenge/innovation”), while 85.25% expressed curiosity to further explore the topic (Q21, “By playing Quizizz, I became more curious to learn the subject”), indicating a high level of engagement and a deep connection to the educational objectives of the activity.

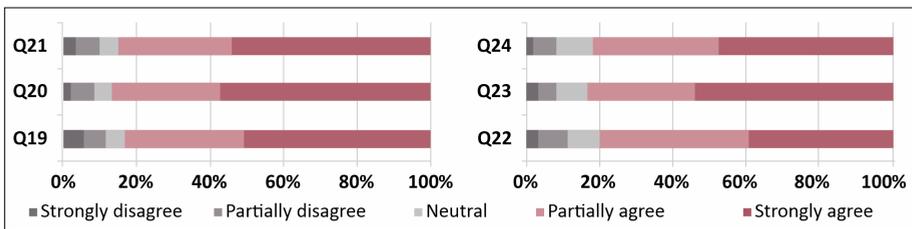


Fig. 8. Questions relating to Guided Autonomy.

A similar trend was observed in the Intrinsic Regulation dimension of Oriented Autonomy, where the individual derived enjoyment from the activity. The majority of responses indicated agreement with the statements provided. While a small proportion of students (11.47%) disagreed with the idea of feeling fully satisfied when playing Quizizz (Q22, “I participate in games like Quizizz because I feel complete satisfaction during the activities”), most students agreed with the other statements, suggesting that the game was effective in autonomously stimulating their interest. Specifically, 81.97% of students felt that game-based activities fully engaged them with the content (Q24, “Activities like Quizizz fully engage me with the content being covered”), and 83.61% agreed that the games helped them discover new things (Q23, “I enjoy activities with games because I can discover new things”), meeting their expectations. This demonstrated that the game was a valuable tool for use in the classroom, particularly for teaching CT.

The tendency towards higher levels of motivation can be better seen when we assign values to the items on the Likert scale, with 1 for “Strongly disagree” and 5 for “Strongly agree”. In order to assess the normality of the distribution of values in each question, the Kolmogorov-Smirnov test was used. This showed that the distribution of these variables was not normal ( $p$ -value < 0.05). We therefore used the median as a measure of central tendency. By averaging the medians of the questions corresponding to each dimension, the agreement index follows the increase in the degree of motivation of the dimension, as can be seen in Fig. 9.

The statements related to Integrated Regulation and Intrinsic Regulation (which, in AT, correspond to the “Autonomy-Oriented” regulatory style) showed the highest levels of agreement, suggesting that the participating students found the Quizizz activity engaging. They answered the questions on their own initiative, seeking challenges and personal satisfaction.

The graphs displaying the participants’ results in the game, in terms of performance (percentage of correct answers relative to the total) and grade (according to the points outlined in Table 2), are shown in Fig. 10. In this case, the median performance was 60% (equivalent to six correct answers), and the median grade was 56 points. Both graphs exhibited little variability and no outliers, indicating a homogenous sample. This can be attributed to the fact that most students were in the early semesters of their respective courses (1st, 2nd, and 3rd semesters for BCS, and 1st semester for IT) at the time of the game.

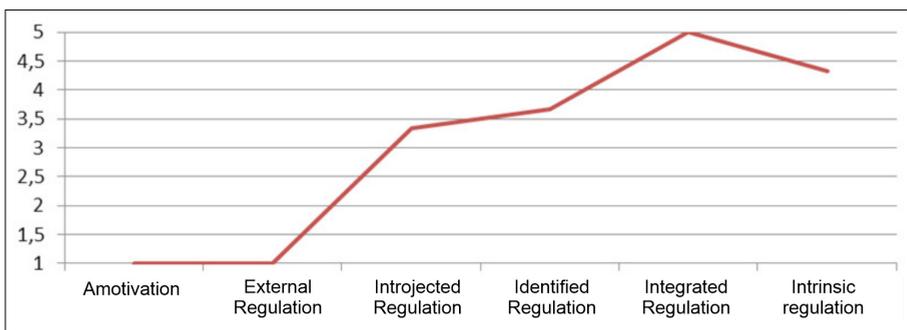


Fig.9. Agreement Index x Regulatory Processes (dimensions).

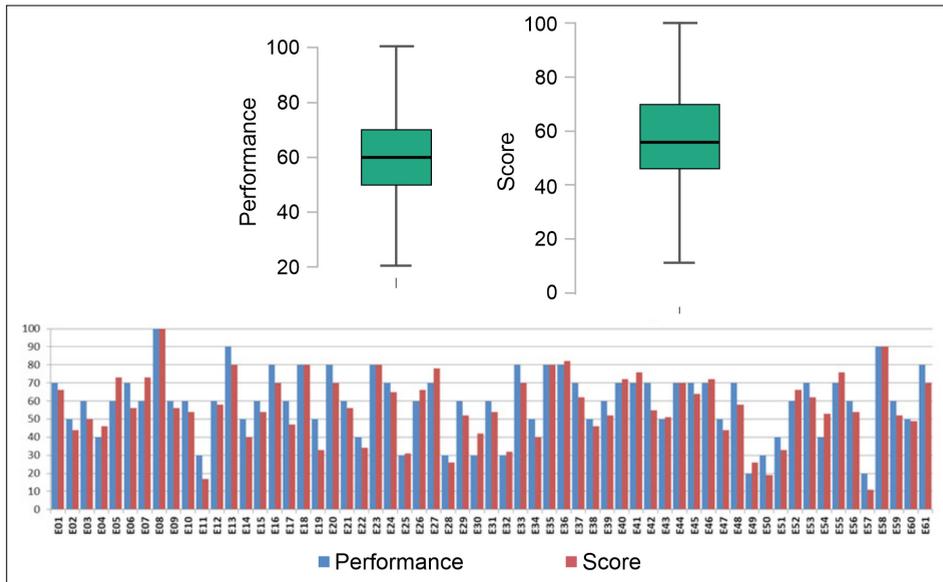


Fig. 10. Students' Performance and Scores.

In order to address RQ2 (“What is the relationship between students’ results obtained through the application of gamified tools, such as Quizizz, for teaching CT and the levels of agreement with the Autonomy-Oriented regulatory style?”) and assess whether the grade or achievement correlates with the levels of agreement regarding the Autonomy-Oriented regulatory style (in the dimensions of Integrated Regulation and Intrinsic Regulation), the Spearman Correlation test was applied.

This non-parametric test was selected because only the Grade variable follows a normal distribution ( $p$ -value = 0.68), while the other variables (Achievement and averages for Integrated and Intrinsic Regulation) do not conform to a normal distribution ( $p$ -value < 0.05). Based on the averages of the Integrated Regulation (R<sub>Inte</sub>) and Intrinsic Regulation (R<sub>Intr</sub>) dimensions, as well as each student’s grade and GPA, the correlation matrix in Table 5 reveals no significant correlation. This indicates that there is no relationship between the R<sub>Inte</sub> and R<sub>Intr</sub> variables and the Grade and GPA variables ( $p$ -value > 0.05).

This result suggests that the grade or achievement did not influence the high levels of agreement observed for these dimensions. This leads us to conclude that the students viewed the activity as valuable for their learning, experiencing satisfaction, fulfillment, or pleasure in participating, irrespective of the results they achieved. This can likely be attributed to the adoption of the gamified tool itself, which engaged them intrinsically and contributed to their overall positive experience.

Regarding the assessment of the Quizizz software, there was a high level of agreement on its effectiveness in meeting the learning demands, as shown in Fig. 11.

The majority of students (80.33%) agreed that the time allocated to answer the questions provided a challenge, stimulating their learning (Q25, “The time provided to an-

Table 5  
Correlation Matrix using Spearman's Correlation test

		Performance	Score	Rintr	Rinte
Performance	Spearman's rho	-			
	p-value	-			
Score	Spearman's rho	0,91	-		
	p-value	< 0,001	-		
Rintr	Spearman's rho	0,14	0,09	-	
	p-value	0,29	0,50	-	
Rinte	Spearman's rho	6,23e-4	-8,15e-3	0,83	-
	p-value	1,00	0,95	<0,001	-

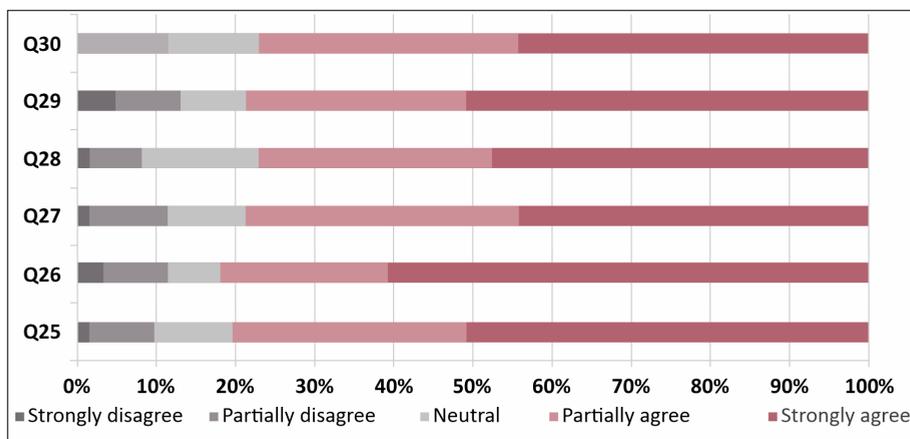


Fig. 11. Questions about the use of Quizizz.

swer the questions allowed for a challenge and stimulated my learning”). Additionally, 81.97% reported feeling motivated to search for the correct answers due to the real-time feedback on their results (Q26, “Knowing in real time whether I got the question right or not motivates me to search for the correct answers”). Most students (78.69%) agreed that the instructions for the activities were clear (Q27, “The statements were clear enough for me to complete the activities”), and 77.05% felt the game was aligned with their level of study (Q28, “The questions were at an appropriate level for the content covered”). Furthermore, 78.69% felt the ranking system encouraged greater participation (Q29, “With the ranking, I feel motivated to participate more and challenge myself”), and 77.05% believed that the Quizizz tool increased their interest in the subject (Q30, “My interest in the subject grew with the use of Quizizz”).

The result from the last question is particularly positive, as it indicates that the use of a single gamified activity successfully sparked greater interest in the subject for over three-quarters of the students.

### 5.2. Qualitative Analysis

Through qualitative analysis of the open-ended responses collected from the instrument defined in Section 4.4, under “Activity Evaluation”, insights were gained into how students assess the implementation of gamified strategies for teaching CT using the Quizizz tool.

Following the Thematic Text Analysis approach, categories were created inductively based on the coded data extracted from the open-ended questions in the questionnaire. In thematic coding, it is assumed that a given passage of text can refer to multiple codes and can, therefore, be assigned to multiple categories (Kuckartz, 2014).

This process led to the identification of thematic categories related to the positive and negative aspects perceived by students in the use of the gamified strategy (“Praise for the gamification elements”, “Criticism of the Quizizz tool”, “Praise for the organization of the activity”, and “Criticism of the organization of the activity”). Additionally, thematic categories emerged regarding how students self-assess their CT skills (“Good or superior performance”, “Fair or inferior performance”, and “Self-reflection on performance”). Fig.12 presents the categories assigned to each student based on their responses. Some students were not assigned categories as they chose not to provide comments in the open-ended questions. In order to address RQ3 (“What are the

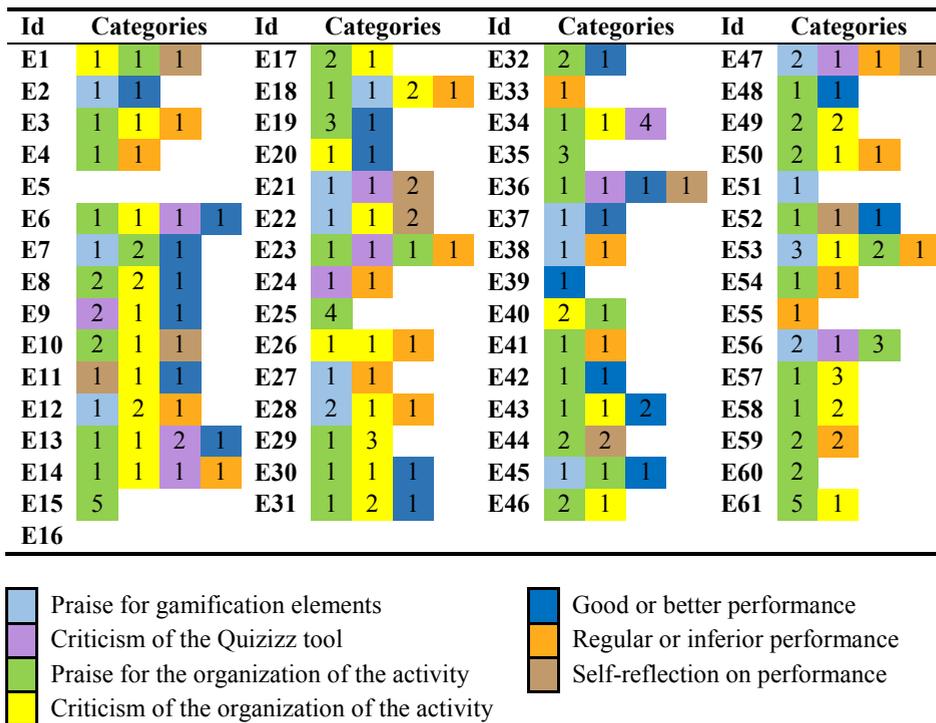


Fig. 12. Categories applied according to student responses.

perceived positive and negative aspects of adopting gamified tools, such as Quizizz, in the CT teaching process?”), positive and negative aspects were highlighted in the following thematic categories:

**Praise for the gamification elements:** The elements of gamification most frequently highlighted by students were: (i) the challenge, (ii) competitiveness, and the (iii) presence of a ranking system. Among these, the challenge received the most praise, with 11 mentions, followed by competitiveness, with 9 mentions. Some students expressed enjoyment in testing their problem-solving skills, viewing it as a positive aspect of the activity. The opportunity to learn through competition or “play” was also appreciated. The real-time ranking, displayed at the end of each question, fostered healthy competition among students, making the activity both dynamic and motivating.

**Criticism of the Quizizz Tool:** While most students enjoyed the activity, some identified issues with the Quizizz platform. A few experienced difficulties with the interface, such as images appearing too small on their smartphones, trouble locating the option to confirm their answers, or being disconnected from the platform due to internet access problems. These issues prevented them from continuing in the game, although they were allowed to return once access was re-established. Additionally, Quizizz only displayed the top scores in real time, and many students expressed a preference for tracking their scores after each question, even if they were not among the top scorers. One student (E47) mentioned that she would have preferred the game’s sound to be softer, as the volume felt uncomfortable to her.

**Praise for the organization of the activity:** Students emphasized that the activity facilitated learning new topics and expressed their enjoyment of this instructional approach. Many noted that the questions were well designed, interesting, and balanced in terms of difficulty, encouraging critical thinking, testing knowledge, and sparking curiosity about the solutions. One student (E15) suggested that this method be used regularly, both on Saturdays and in the classroom. Others expressed a desire for more questions or additional activities using Quizizz, describing it as fun, dynamic, and innovative. In addition, one student (E49) appreciated the communication with the teacher, noting that the interaction after each question, where solutions were explained, enhanced the learning experience.

**Criticism of the organization of the activity:** While most feedback on the activity was positive, many students felt that the wait time for the correct answer was too long (25 codings). This long wait made it difficult for them to quickly know if they were right or wrong, and in some cases caused anxiety. However, three students (E12, E29, and E46) mentioned that they actually found the time to answer the questions too short. Some students also found the questions challenging, despite starting at an easier level, and felt that the wording of the questions was too long, confusing, or complex. One student (E10) said they missed having questions specifically about computers, while another (E26) wished there had been a reward for those who answered the hardest questions correctly. Table 6 shows some student quotes about positive and negative aspects of this experience.

Table 6  
Positive and negative opinions reported by students

Positive opinions	Negative opinions
“This method is quite fun”	“It was a little difficult because I can’t think under pressure”
“I liked everything, the quiz was innovative”	“I couldn’t focus on just one thing at a time”
“I liked it because it was a dynamic, interactive and very useful activity, I learned new concepts while playing.”	“Few questions, there should be more”
“I liked the competitiveness as a driving factor for greater dedication”	“Some questions were long, which hindered my reasoning.”
“This way of learning was great, each one on their cell phone without any embarrassment of making mistakes.”	“Overly complex statements in the final questions”
“The questions were very good, plus the fact that there is a real-time ranking, which encourages healthy competition among students.”	“The delay in getting the questions’ result made me anxious to know if I was right or wrong.”
“It was challenging, we thought in a way to solve problems.”	“I would like the sound to be a little softer so it doesn’t become annoying.”

In order to answer RQ4 (“According to the students, how do they evaluate themselves, and what reflections do they have regarding the CT skills they practiced?”), the following thematic categories address this matter.

**Good or superior performance:** A total of 22 students rated their performance as good or better, with two of them (E36 and E37) mentioning that their results exceeded expectations or came as a pleasant surprise. Of these, only five students (E19, E35, E42, E45, and E48) rated their performance as very good or excellent.

**Average or below average performance:** A total of 25 students rated their performance as average or below average, with many expressing a desire to have answered more questions correctly or to have scored higher. Two students (E44 and E59) felt their performance was worse than expected, while two others (E22 and E38) felt their results were very poor. One student (E34) mentioned that he had difficulty progressing in the game due to Internet access problems, which prevented him from performing well.

**Self-reflection on performance:** This category aimed to collect students’ reflections on their own results in the game. Some admitted that their mistakes were due to lack of attention or carelessness (E10, E21, E22, E44) and realized that they could have done better if they had been more focused. One student (E43) mentioned that he only understood the questions after seeing the answers, another (E47) said that he had difficulty concentrating on one thing at a time, and a third (E36) found the game challenging because he had difficulty thinking under pressure. Overall, most students acknowledged the need to improve their reasoning and numeracy skills, with one student (E25) even stating that he planned to revisit the questions he got wrong later.

### 5.3. Mixed Methods Analysis

The integration of quantitative and qualitative data is a fundamental feature of mixed methods research (Creswell and Clark, 2017). In line with the mixed methods case study approach, the quantitative findings were combined with the qualitative findings to better understand the case in question (Guetterman and Fetters, 2018). Therefore, in this step, our goal was to evaluate what results could be inferred from the comparison between the results of the quantitative method, which assessed students' self-determination, and the qualitative method, which collected their opinions about the activity. Hence, the following findings answer the RQ5 ("What results emerge from comparing the findings obtained through the quantitative method, which assessed students' self-determination, with the qualitative method, which captured their opinions of the activity?").

Regarding the dimensions related to the impersonal orientation (Amotivation and External Regulation), the result confirms that there are practically no amotivating aspects in the proposed game, as most students showed interest and praised the gamification elements present in the activity (such as the challenges, the competition and the real-time ranking). However, some students agreed that the use of Quizizz was not helpful or that they were not interested in games in class. This can be explained by the criticisms reported about the Quizizz tool, in particular the problems found with the interface and/or the use of the tool, which made it difficult for some students to interact appropriately.

There was also a low level of agreement in the External Regulation dimension, indicating that students would be willing to participate in the gamified activity even in the absence of punishments or rewards. However, it is important to emphasize that the gamification elements themselves – particularly the real-time ranking – can be seen as a form of extrinsic motivation for students, who may see their position on the ranking as either a punishment or a reward, depending on the outcome. Other factors that could explain the agreement of some students with the statement that they played Quizizz expecting benefits include participating on a Saturday and receiving the certificate of participation for additional hours, as mentioned in the invitation to the activity. In this context, it is worth noting that one of the students asked for a prize for those who answered the most difficult questions correctly, which also characterizes the need for extrinsic motivation.

In the controlled regulation style, Identified Regulation is assessed by examining whether the student has a better understanding of the task at hand by seeing the game as something that can help review content or get good grades. At this point there was a tendency towards agreement in the quantitative evaluation. This can also be seen when students in open responses asked for more quizzes or more questions in the game, or even when they asked for similar games on other Saturdays or in the classroom.

Finally, in the autonomous regulation style, the dimensions of Integrated Regulation and Intrinsic Regulation are analyzed. With regard to Integrated Regulation, which assesses whether the student considers the activity to be important for their learning, the highest level of agreement was obtained of all the dimensions assessed. Indeed, this is evidenced by the fact that many students reported that Quizizz was a challenge/innovation that made them feel capable of learning new topics, encouraged them to think, to test their knowledge and to be curious about how to solve the questions.

The Intrinsic Regulation also showed high levels of agreement. This dimension corresponds to intrinsic motivation, where it is assessed whether the student enjoys doing the activity autonomously. This result can be confirmed by the positive feedback from the students in the open responses, even though a median result was obtained in terms of grade or performance in the activity. The level of indifference or disagreement was around 20%, which was also reflected in the students' responses when some stated that they had difficulty concentrating, thinking under pressure or understanding the questions. These factors may have caused discomfort or annoyance, preventing students from reaching a state of intrinsic motivation, i.e. personal satisfaction and well-being with the activity.

## **6. Limitations**

This study has a number of important limitations. First, the sample used was non-probability, which limits the generalisability of the results. However, the study still provides valuable insights into how students evaluate the use of gamified strategies in Computing Education.

Another limitation is that although students were instructed to play individually, there is no guarantee that all students followed this instruction. This may have affected the performance and grade measurements. In addition, as a single, specific case study, the research does not delve deeply into the learning process or long-term retention of knowledge. A more comprehensive analysis would require observing multiple interventions over a longer period of time and taking into account other variables.

## **7. Conclusion**

This article describes an intervention for teaching Computer Science (CS) to students in a Bachelor's Degree in Computer Science and in a Subsequent Technical Course in Computer Science (IT course), using gamification as a motivational strategy and the Quizizz as the platform. The results obtained from the use of this tool were analysed through a case study and compared in the light of SDT.

The results showed that: (i) the regulatory style that students most identified with during the game was "guided autonomy", where the individual acts on their own initiative, seeking challenge and personal satisfaction, with a clear and defined goal, and particularly in the dimension "Integrated Regulation", where the individual identifies the activities with their own desires and values and sees them as important for their learning; (ii) grades or performance did not correlate with the high levels of agreement obtained for this regulatory style, i.e. students saw the activity as important for their learning – they found satisfaction, fulfilment or pleasure in doing it – regardless of the performance achieved; (iii) among the positive points of the activity from the students' perspective, the presence of gamification elements (such as challenges, competition and ranking) and the methodology and dynamics used for the activity with the Quizizz tool and the ques-

tions that trained CS skills; (iv) among the negative points mentioned by the students regarding the activity, the time limit for each question, which was considered too long by most of them, and some problems with the interface and/or the use of the Quizizz tool, such as difficulties in confirming answers or disconnection during the game; and (v) in the self-reflection on performance made by the students themselves, many mentioned a lack of attention as a factor for not achieving better results, as well as the need to practice more logical reasoning and CS skills. However, most enjoyed the experience and reported that they would like to repeat it more often, including in the classroom.

This experience is considered important because it provides a fun and motivating way to train CS skills and develop algorithmic and problem-solving skills. These skills are crucial for teaching programming and computational logic in introductory computer science courses, where there are high failure and dropout rates. By developing students' Guided Autonomy, this methodology is useful not only for teaching CS, but also for teaching foundations of programming or even other subjects. As future work, it is intended to carry out more interventions over a longer period of time and/or apply this game to several different classes to better understand the learning process with the Quizizz platform in teaching Computer Science and algorithms.

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