

Amanda Ribeiro Fontes and Gabriel Rios Torres

**Digital games in education:** applying the Game-Based Learning methodology to teaching computational thinking

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Final Course Project submitted to the Institute of Technology and Leadership (INTELI), to obtain a bachelor's degree in Software Engineering and Computer Engineering.

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## **Epigraph**

A child's play is not simply a reproduction of what he has experienced, but a creative reworking of the impressions he has acquired. (Lev Vygotsky)

## Abstract

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Traditionally associated with entertainment, games can be used as playful-pedagogical tools in educational environments, especially in basic education. The subject of introductory programming presents significant challenges for students entering computer science courses or for those who show an interest in the area, thus requiring approaches that allow students to overcome the barriers imposed by the traditional teaching system. In this sense, Game-Based Learning - a learning methodology based on the use of digital games to assimilate new knowledge - is highlighted as a potential transforming agent in the students' pedagogical process. To investigate this premise, an experiment was carried out with high school students with no previous experience in computing, during which dynamic lessons were conducted using educational software structured in the form of a game. The expected results include a high satisfaction rate in relation to the workshops given and improved performance in subsequent theoretical and practical assessments, demonstrating the potential benefits of this approach in promoting engagement and improving learning processes in Brazilian educational institutions.

**Palavras-Chave:** computational thinking; active learning; digital games; education; game-based learning

## Summary

1 Introduction	8
2 Development	9
<b>2.1 Evolution of the Research</b>	<b>9</b>
2.2 Obstacles and Challenges	11
3 Conclusion and Final Reflections	12
References of the article	14

## 1 Introduction

Game-Based Learning, as an active learning methodology, is believed to hold significant potential for programming education in basic education institutions in Brazil. To test this hypothesis, the authors intend to conduct a study with high school students who have no prior knowledge of programming yet demonstrate an interest in entering the field. It is anticipated that adopting this methodology could reinforce the acquisition of computational thinking, a skill considered fundamental in today's context. Investigating the influence of game-based solutions in programming education underscores the importance of adopting innovative strategies within educational institutions. This approach suggests that gamified methods can render the learning process more dynamic and engaging, thereby reducing dropout rates and stimulating student interest from the basic education cycle onward. Furthermore, research into Game-Based Learning aims to expand access to programming education nationwide — challenging the paradigm that the discipline is exclusive to students with superior cognitive abilities or greater resources — and to promote the retention of students enrolled in higher education computing courses, ultimately encouraging the formation of professionals well-equipped for the labor market and fostering the development of innovative methods for conveying complex content.

The general objective of this study is to investigate the influence of pedagogical approaches grounded in the Game-Based Learning methodology on the development of computational thinking. To achieve this objective, the study aims to identify the main game-based approaches currently used in the teaching of computational thinking, as well as to analyze trends related to the adoption of these methodologies in educational contexts. In addition, the research seeks to evaluate the development of computational thinking skills in students who use strategies derived from Game-Based Learning, as well as to collect information on students' perceptions and experiences throughout the learning process. Finally, the study proposes a critical analysis of the benefits and challenges associated with the application of game-based methodologies in the teaching of computational thinking. These specific objectives are directly aligned with the general objective, as they break down the investigation into complementary analytical stages, enabling a comprehensive understanding of both the pedagogical impact and the practical implications of using Game-Based Learning in this educational context.

## 2 Development

### 2.1 Evolution of the Research

During the first ten weeks of project development, corresponding to the first academic module of the year, the authors made significant progress in the ongoing research. Initially, alignment meetings were held with the faculty advisor overseeing the project, leading to the formulation of a Project Plan that outlined the initial proposal as well as the roadmap for the research development journey. Subsequently, a literature review phase was conducted, during which the authors sought relevant articles and examined the existing body of knowledge related to the topic.

Additionally, the research target audience was defined, establishing the specific elements encompassed by the project. An educational institution was selected, and negotiations were initiated to implement the methodology in partnership with the chosen school.

Regarding the writing of the article, the introduction was developed, including the literature review and outlining the researchers' objectives with the study. The planned process for the remainder of the year was described, and portions of the methodology section have already been incorporated into the article.

In preparation for the lesson plan to be implemented with the volunteer students, a form was created to recruit participants for the pedagogical experiment. Furthermore, an initial diagnostic questionnaire was developed to assess students' prior knowledge of computational thinking, as well as a final evaluation form to be administered after the sequence of lessons conducted by the researchers.

Weekly meetings have been held to present the research progress and to define the next steps of the project.

During the second module, the initially planned activities had to be reviewed and reformulated, since they were contingent on a partnership with an institution that did not materialize. During this period, the Introduction and Methodology sections of the article were rewritten to detail the bibliographic survey and article analysis process, as well as to clarify the course design, implementation, and data collection, without linking to any specific institution.

Additionally, a mapping of related high schools was carried out to establish new contacts. The teaching plan was finalized, enhancing the relationship between content and lessons, including activities planned for asynchronous moments. Also in this module, an action plan for the experiment was developed, detailing all steps for its execution, including dissemination strategies, participant selection, and specifications of synchronous and asynchronous models to be adopted.

Infrastructure planning for the event was also conducted: contacts were made with the venue, dates and times were scheduled, and equipment management teams (such as laptops and projectors) were contacted to ensure the event runs smoothly. Although the registration form was released and initial marketing actions were undertaken, due to short notice and low participation, these efforts were suspended.

The academic recess between the second and third modules was dedicated to resolving the previously reported challenge: the authors initiated negotiations with the Eurofarma Institute, whose student demographic perfectly aligns with that of this research. The successful partnership led to the establishment of September 13 and September 20, 2025 — two Saturdays, as initially planned by the authors — as the dates for the Game Changers Workshop, to be held at the institute's headquarters.

The Institute's coordination was instrumental in managing workshop registrations. The initiative was promoted among the students, and registrations remained open for one week. In the subsequent week, a communication channel was created, and the students were added to a dedicated Google Classroom to access the asynchronous activities and begin their preliminary studies in Computational Thinking.

The workshop was conducted successfully on the stipulated dates. All registered students attended both days of class, resulting in a 100% attendance rate. All proposed classroom dynamics, synchronous activities, assessments, and feedback sessions demonstrated significant student participation and engagement. This high level of involvement generated the necessary input for the researchers to conduct a robust data analysis and achieve satisfactory preliminary results.

The authors of this research conclude the third module of the project by analyzing the results obtained from the workshop and proposing discussions regarding the reported experience.

The first step of the fourth module consisted of processing, cleaning, and analyzing the qualitative and quantitative data collected during the workshop,

including students' scores from the diagnostic and final assessments, data obtained from feedback forms, and the completion of asynchronous activities.

After the analysis, the data were organized and represented through graphs and tables, and the previously reviewed literature was revisited to support the writing of the results, discussion, and conclusion sections. Additionally, the methodological section was enriched by incorporating students' drawings and an account of the experience carried out during the intervention.

Finally, the authors refined the manuscript as a whole, prepared a presentation for the evaluation committee, and submitted the paper to the selected journal.

## 2.2 Obstacles and Challenges

In the first module, a significant obstacle faced by the authors was obtaining authorization for the proposed experimentation, as it depended on the support of an educational institution that would enable the implementation of the pedagogical workshops. During this period, the researchers were in negotiations with the school considered most suitable for conducting the study. However, there is a possibility that the negotiation may not be successful, which would require seeking another institution for the application of the Game-Based Learning methodology. This limitation currently represents the main concern regarding the progress of the research and may necessitate adjustments to the initially proposed timeline.

In the second module, a new obstacle emerged related to the difficulty in reaching the target audience for registration dissemination, since both authors lack familiarity and established connections with this group. To overcome this barrier, a marketing strategy revision plan was developed, including new approaches for contacting educational institutions that, so far, have shown promising potential to facilitate dissemination and participant recruitment.

The third module of the project yielded positive outcomes regarding all previously presented challenges. However, a few obstacles emerged during the execution of the Game Changers Workshop. Primarily, the number of students present in the classroom exceeded the number of students registered. This occurred because some students attending their respective courses at the Eurofarma Institute did not form a sufficient quorum for their scheduled classes and, moreover,

expressed interest in participating in the workshop. Consequently, 23 students were allocated to the class, which demanded logistical improvisation during the session.

In addition to this mentioned obstacle, the second workshop session presented a further challenge: the poor quality of the institution's network connection at the day rendered one of the planned in-class activities unfeasible. This activity involved the use of a game designed to teach Computational Thinking. To circumvent this issue, the authors quickly adapted by displaying the game from a single computer via the classroom projector. Students were then encouraged to interact and collaboratively complete the game stages while the actions were executed by one of the researchers. Apart from the aspects mentioned, there were no major impediments concerning the execution of the workshop.

In the fourth module, which focused on data processing, data analysis, and the conclusion of the article, one of the main challenges encountered was the categorization of data of a nature different from what had initially been expected. When students were asked to provide negative feedback about the workshop, many responses were paradoxical in nature, such as "none" or "there is none," which hindered the categorization process. To address this limitation, the authors employed Content Analysis as proposed by Bardin (1977), enabling the construction of thematic categories suitable for the interpretation of the collected data.

### 3 Conclusion and Final Reflections

During the first module of the project, the students were able to significantly deepen their understanding of the topic chosen for the development of their final course project. They acquired new knowledge related to conducting research involving experimental procedures, as well as developing skills in academic writing. The authors outlined the purpose of applying the Game-Based Learning methodology in the context of teaching computational thinking and presented a methodological proposal to be implemented in the following module.

In the second module, despite the delays faced, the period was extremely rich for the development of the work, mainly due to the theoretical deepening carried out for the application of the methodology. Progress in negotiations and communications established with institutions also provided the students with the development of interpersonal skills, thus going beyond the writing of the article. The researchers

remain confident that the study has great potential to generate significant results regarding advances in education in Brazil — especially in promoting knowledge about Computational Thinking.

The third module of the project was particularly significant for the research authors, as it was the period during which the workshop was finally conducted, following the successful overcoming of all previous obstacles. The authors gained direct experience in teaching Computational Thinking to high school students and, for the first time, acquired practical knowledge regarding classroom instruction. Moreover, observing the participants' high engagement in both synchronous and asynchronous activities, and receiving positive feedback, reinforced the premise under evaluation by the researchers. They now possess significant input to proceed to the final stage of this study.

The fourth module encompassed the stages of data cleaning, processing, classification, and analysis of the data collected during the workshop period. In addition, the results, discussion, and conclusion sections of the article were written, along with a comprehensive refinement of the manuscript. The authors also revisited the literature in order to contextualize, interpret, and assess the research outcomes, culminating in the submission of the paper to the selected journal. Ultimately, the research question — “Can the use of digital games contribute to motivation, engagement, and the understanding of the fundamental concepts of Computational Thinking?” — was answered positively, based on the significant improvements observed among students after the workshop, as well as on responses to engagement assessment instruments, which demonstrated the effectiveness of the adopted approach.

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