Implementing LiGa – literature and gamification: Usability and Effectiveness of Analog Gamification in Brazilian Elementary Education

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Abstract. *This paper investigates LiGa – Literature and gamification, an analog educational strategy aimed at modernizing literature education for public elementary schools in Brazil. It was developed considering Brazil's disparities in digital access and public education challenges. LiGa integrates gamification concepts into printed didactic materials. The study assesses LiGa's usability and effectiveness through teachers perceptions, within the public education network of Itararé-SP, where it was first implemented. For this study, it was primarily used the System Usability Scale (SUS). Findings indicate good usability, in face of specific considerations and limitations of this implementation and research.*

1. Introduction: what is LiGa

This paper explores the implementation of LiGa, an analog gamified educational tool designed to enhance literature education in Brazilian public schools. It assesses the usability the material by teachers, examining their perceptions and experiences through quantitative surveys conducted during training sessions. LiGa – Literatura e Gamificação (LiGa – Literature and Gamification) is a fully developed education strategy built as a printed didactic kit for literature classes. It was developed with the aim of modernizing educational strategies to stimulate literary fruition in the first five years of elementary school – children aged between 5 to 11. One of its developmental premises was the disparity in access to digital technologies and the difficulty of implementing new solutions in public networks throughout Brazil, while also acknowledging the growing popularity of digital entertainment games (Prado et al., 2021, 2022). The solution was to create an analog gamified educational strategy in the form of didactic material, to present and develop literary habits in the early years of elementary education.

Each year contains a teacher's kit and a kit for each student. Students receive a kit with four specific literature books, a journal where they write the class activities, and an interactive magazine about literature and games for their family – "Guia da Família" (family guide). Teachers receive a different kit: with the same literature books; a teacher's guide with class planning and all instructions on how to implement; all the playful pieces that will be used by students, including all stickers, posters, dice, cards, etc., that are used for each gamification, made specifically for each of the literature books. Essentially, every literature book becomes an interactive adventure for students, with playful context based on each book. These adventures are carefully planned for eight classes and always

DOI: 10.5753/sbie.2024.242659

culminate in the creation of the “O Legado da Turma” (legacy of the class), a creation of the whole class that symbolizes their journey together.

It was developed in accordance with Base Nacional Comum Curricular (BNCC) (Ministério da Educação: Brasília, 2018), which is the national educational guideline, with the following points:

Integration of literature into the school curriculum: LiGa aligns with the BNCC by emphasizing the importance of literature in the formation of well-rounded individuals. The BNCC encourages the use of a variety of literary texts to develop in students a love for reading, becoming "reader-enjoyers" (BNCC EF15LP09) (CIEB, 2024).

Use of technologies in education: LiGa follows the BNCC guidelines that recommend incorporating technologies into the school environment. Although LiGa uses analog gamification, it adopts game design principles often associated with digital technologies (BNCC EF05HI08) (CIEB, 2024).

Focus on the holistic development of students: The BNCC highlights the need to provide meaningful experiences that contribute to the holistic development of students, including cognitive, emotional, and social aspects. By gamifying literature teaching, LiGa aims to make learning more engaging and meaningful, meeting this guideline (BNCC EF02CI01) (CIEB, 2024).

Active learning methodologies: The BNCC supports the use of active methodologies that place the student at the center of the learning process. LiGa, with its journey diary and dynamic activities, encourages active student participation, promoting autonomy and protagonism in learning (BNCC EF05LP10) (CIEB, 2024).

Development of competencies and skills: The BNCC is oriented towards developing essential 21st-century competencies and skills such as critical thinking, creativity, and collaboration. LiGa's gamified approach helps develop these competencies by engaging students in activities that require problem-solving, decision-making, and teamwork (BNCC EF09AR17) (CIEB, 2024)

LiGa is sold for public networks in Brazil, and along with the physical product, these networks also receive a cycle of training, with four workshops and a lecture on LiGa and its constructs and fundamentals, such as literature and gamification. These workshops are not designed for training teachers on how to use LiGa but to expand their knowledge and tools on these topics. However, only teachers that will utilize the material are usually permitted to participate. This research was conducted during these workshops, at the end of each class.

The structure of this paper is organized as follows: Section 1 introduces the LiGa project and its relevance within the context of educational technology. Section 2 reviews the theoretical foundations, including concepts of gamification and usability. Section 3 details the research methodology, including the data collection process and analysis techniques. Section 4 presents the findings from the study, while Section 5 offers conclusions and suggestions for future research.

1.1. Gamification for education tendency pre-COVID-19 pandemic

It is important to note that pre-COVID-19 pandemic, educational technology development favored digital technology, especially regarding gamified solutions,

something evidenced by the lack of recent research on analog gamification. LiGa development was, at the time, contrary to popular belief in a full stance on digital gamification for education.

1.2. Public education problems leading to LiGa's creation

Historically, Brazil has had low PISA scores, especially regarding reading, which still does not translate to reading literature. In 2022 PISA, 50% of Brazil's students scored below level 2 of reading, compared to the average 26% of students of OECD countries (OECD, 2022). Also stated in 2022 PISA is the newly evaluated creativity rate, where 54.3% of Brazilian students, aged 15, showed low levels of creativity (INEP, 2023).

LiGa is a completely non-digital gamification material designed to address some of the historical issues in Brazil's public basic education, such as the lack of resources and unequal access to technology; the difficulty of mass training for teachers in larger public networks in order to use specific digital technologies; the rigidity of digital gamified solutions that are often built ad hoc and thus reduce teachers' autonomy; and the excessive screen time, which is proven to be harmful (Lissak, 2018) and now faces prohibition policies by public networks, such as in Rio de Janeiro (Prefeitura/RJ, 2024).

In face of such problems, Brazil's public education system still faces many challenges regarding the implementation of new technological solutions. Public elementary schools are administered by each municipality, with its own orientation and policies. The two major challenges regarding LiGa's implementation are cost and its adoption by teachers. While cost is an objective barrier, related to public investment policies, specific to each municipality and unrelated to this study or LiGa's development, the second issue is directly related to LiGa's guiding development principles of engaging students with literature and being easy to implement by teachers. In relation to its adoption by teachers, LiGa faces possible resistances, due to the still current prejudice with games and derivatives being used as educational tools (Almeida et al., 2021) and for it being different than usual didactic materials (INEP, 2023).

1.3. Delimitation and research questions

This paper focuses on the implementation and usability of LiGa by teachers within a specific public education network in Brazil. It does not address the effectiveness of gamification and its diverse use, since this is an ongoing discussion, with several papers, at bare minimum, indicating the effectiveness of gamification in education in relation to student's motivation (Bai et al., 2020). Furthermore, this study is limited to the initial stages of implementation and how teachers perceive LiGa's usability so far, as the project continues to be implemented at the network in question and with predictions of implementing in other public networks of Brazil. As it is explained further on this paper, future research will likely inquire on the application and results of LiGa from the student's perspective.

This paper will focus on essential editorial components, as these are directly linked to the usability and adoption of the material by teachers. While this paper will address some of the key problems of Brazil public education that led to the development of LiGa, it is not the focus of this study to debate or further develop on these issues – which are already widely debated – such as the importance of literature and the role schools play in its approach.

The main questions this study intends on answering are: **How do teachers perceive the usability and effectiveness of the LiGa educational strategy in enhancing literary engagement and learning outcomes in elementary education? Which editorial structure of the material is perceived as more useful for comprehending LiGa?**

The study hypothesizes that teachers will find LiGa user-friendly, albeit the challenges expected towards its usability, and that its gamified approach will positively influence their attitudes towards using it. For more information about LiGA, visit https://mvteducacao.com.br/projetos-educacionai/liga/

1.4. Terms and definitions

Technology and its definition have long been the goal of academic discussions, however, for this research, we shall use its usual meaning as established in common dictionaries of Brazil – as tools, methods, and techniques developed for solving problems or specific purposes (Michaelis, 2024). And as thoroughly discussed by Langdon Winner, as more than tools and apparatus, with inseparable concepts, culture, and perception related to any specific or general technology (Winner, 1991). Such as is the case with games, game culture, and game use in education. For this reason, LiGa is a physical, non-digital product, that was developed with a specific analog gamification methodology, but also an educational strategy, which implies and requires a teaching practice – all of which is technology.

2. Theoretical References

2.1. Gamification in education

Gamification, as defined by Sebastian Deterding, involves the application of game design elements and principles in non-game contexts to enhance user engagement, motivation, and overall experience. This approach integrates components such as points, badges, leaderboards, challenges, and narrative elements into educational activities and content. The primary aim of gamification is to make tasks more engaging and motivating, thereby increasing participation and interest.

This technique that utilizes game characteristics and elements to stimulate intrinsic motivation and consequently engage, can be used for digital and non-digital creations in education. However, it did stem and grow as a discussion, from digital technology (Burke, 2015).

Game-Based Learning (GBL), on the other hand, utilizes complete games as educational tools. This method involves the use of complete games, usually commercial entertainment games, to teach or stimulate interest in particular skills, concepts, or subjects. The educational content is approached with the use of a game – to stimulate interest in a related topic or as a means of interacting with such topic - and sometimes, modifying conventional games to integrate content into its narrative and mechanics. Nevertheless, GBL focuses on leveraging the interest in games as well as its interactive nature to facilitate learning in a structured environment, and always utilizes a complete game.

While gamification incorporates game elements into non-game activities to enhance engagement, game-based learning uses entire games as the primary medium for delivering educational content (Al Fatta et al., 2018).

2.2. Usability

Usability, as per the Merriam-Webster dictionary definition, is "the quality or state of being usable: ease of use" (Merriam-Webster, 2024), referring to the ease with which users can learn and utilize a tool or system for a specific purpose. This concept was brought to light by Donald Norman in his iconic work, “The Design of Everyday Things” (Norman, 2013).

While the notion is not exclusive to digital technologies, it has expanded in terms of discussion and area of study as a consequence of digital tools, their interfaces, and human-computer interaction. Usability is now seen as one element within the user experience (UX) discussion, which involves other considerations such as emotions and behavioral psychology.

While Norman’s initial focus was on the usability of tangible tools and everyday items, his ideas have since been extended and applied to a broader range of contexts, including digital interfaces, processes, and methodologies.

Many models were developed to evaluate a system’s usability. The System Usability Scale (SUS) was developed by John Brooke in 1996 (Brooke, 1996) and is a widely used model for assessing usability, providing a reliable and nonspecific manner of understanding the ease of use of various systems. It consists of a 10-item questionnaire with five response options ranging from "Strongly Disagree" to "Strongly Agree." The items are designed to cover various aspects of usability, such as ease of use, complexity, and overall satisfaction (Table 1).

Table 1 - SUS questionnaire

1 - I would like to use LiGa frequently;
2 - I found LiGa unnecessarily complex;
3 - I found LiGa easy to use;
4 - I think I would need the support of a technical person to be able to use LiGa;
5 - I thought the LiGa activities were well integrated;
6 - I thought there were a lot of inconsistencies in LiGa;
7 - I imagine that most teachers would learn to use LiGa very quickly;
8 - I found LiGa too complicated to use;
9- I felt very confident using LiGa;
10 - I needed to learn a lot of things before I could start using LiGa.

The calculation of the SUS score involves several steps. First, the score contribution for each item is determined. For odd-numbered items (1, 3, 5, 7, 9), the score contribution is calculated by subtracting 1 from the user’s response. This shifts the scale from 0 to 4, where 0 represents the least favorable response and 4 represents the most favorable response. For even-numbered items (2, 4, 6, 8, 10), the score contribution is calculated by subtracting the user’s response from 5. This also shifts the scale from 0 to 4, where 0 represents the most unfavorable response and 4 represents the least unfavorable response. Next, the score contributions for all ten items are summed to obtain a total score. Since each item contributes a value between 0 and 4, the total score will range from 0 to 40. The total score is then multiplied by 2.5 to convert it to a scale of 0 to 100. This final SUS

score provides a normalized measure of usability, with higher scores indicating better usability.

In this study, SUS was used to evaluate LiGa's usability by teachers, since its implementation requires comprehension of its components – how and when to use it – and the teacher guidebook. However, while the SUS model has broad applicability, no study has been found showing SUS use for a printed educational technology such as LiGa.

2.3. Applying digital concepts to non-digital technologies

Although concepts like usability and gamification originated or were significantly expanded through discussions around digital technologies, their principles are equally applicable to non-digital contexts. Gamification, for instance, does not inherently require digital tools. A common example is the feedback card system used in retail, where customers accumulate marks for each use and receive a reward upon reaching a predetermined threshold.

Similarly, usability principles can be applied to any system or product, regardless of its digital nature, to enhance the user experience. The LiGa project leverages these principles to develop an educational tool that is both effective and user-friendly. By incorporating the motivational elements of gamification into printed didactic materials, LiGa aims to create an engaging and accessible educational strategy for elementary literature classes.

3. Methodology

The research utilized a quantitative approach, employing surveys administered at the end of each encounter with teachers to gather data. The study was conducted within the context of a series of training sessions focused on the implementation of LiGa. Teachers were introduced to the concepts of LiGa, including gamification and literature, through an initial online lecture, followed by a sequence of four workshops. To assess the teachers' perceptions and experiences, questionnaires were specifically tailored for each session and distributed in print at the conclusion of each workshop. For the purpose of this study, the questions and answers were translated into Portuguese and administered through printed questionnaires handed to the teachers at the end of each workshop, specifically tailored for each day.

Itararé-SP is a small educational network, consisting of 25 elementary schools with a total of 388 elementary school teachers (IBGE, 2024). LiGa kits were distributed to 132 teachers, with the selection process for these teachers being determined by the network. While the training cycles were recommended, participation was not mandatory, leading to expectations of less than full attendance.

The initial online lecture occurred on March 20, 2024, with two sessions offered throughout the day. Despite expectations, only 42 teachers attended. At the end of each lecture, a Google Forms questionnaire was announced, collecting a total of 26 responses by the end of the day.

3.1. Initial contact with LiGa concepts

In the initial phase of introducing the concepts of LiGa—literature and gamification—teachers were surveyed regarding their familiarity with games. They were asked how frequently they played board games and digital entertainment games (Figure 1).

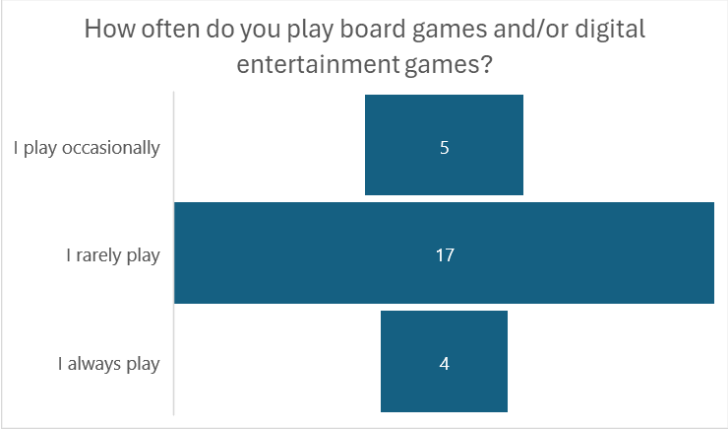

Figure 1 – Familiarity with games.

Teachers were also asked, “In your opinion, how different is the LiGa approach compared to other didactic materials in stimulating literary reading?” (Figure 2).

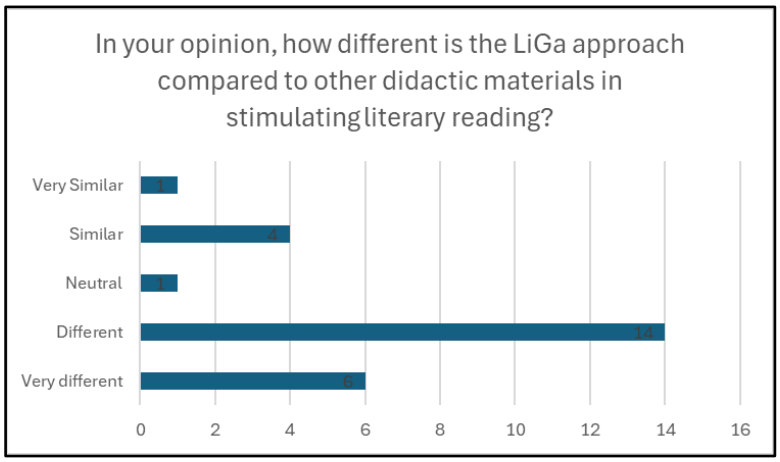

Figure 2- LiGa compared to other didactic materials with similar goals.

Regarding their experience with non-traditional didactic materials, see Figure 3:

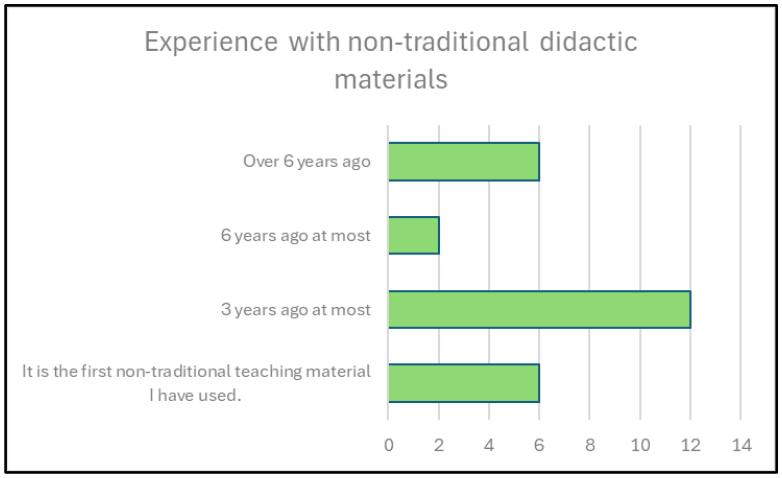

Figure 3 - Experience with non-traditional didactic materials.

Teachers' agreement with the statement, “Gamification is usually associated with digital media,” on Figure 4:

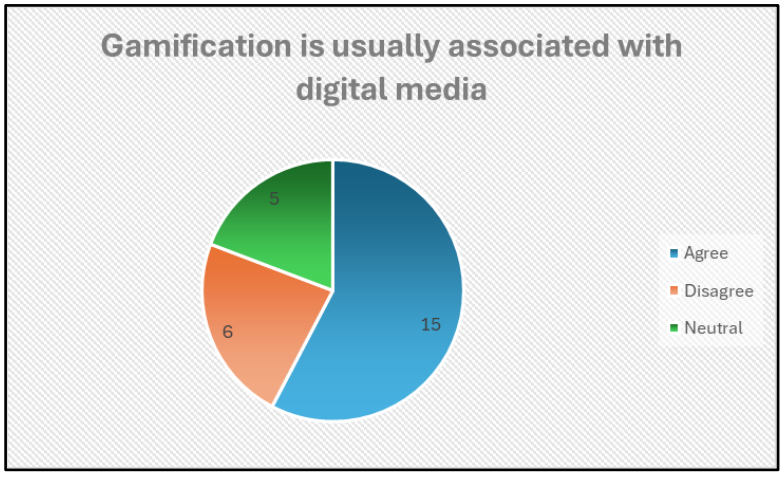

Figure 4 – Perception of gamification.

The average teaching experience was 12.8 years, with the average teacher age being 38.

3.2. First workshop

The first workshop took place on March 27, 2024, with four classes conducted on the same day—two in the morning and two in the afternoon. A total of 93 teachers attended, with 66 completing the questionnaire. However, one morning class did not participate due to logistical issues, affecting the total number of responses.

Questions regarding LiGa's usability, and the perceived effectiveness of its editorial structures included: "Which of these LiGa structures was most useful for understanding LiGa?" detailed in Figure 5:

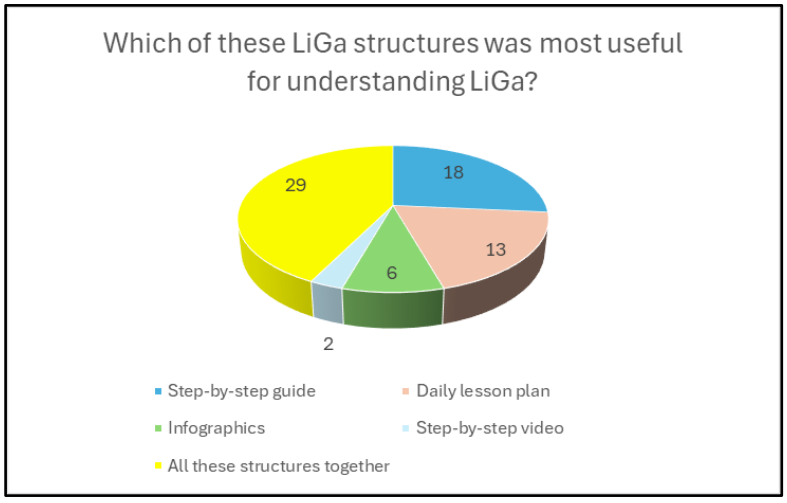

Figure 5 - LiGa editorial structures.

When asked about "Was the lesson plan structured in 'Before, During, and After,' with visual examples from the Journey Diary, easier to implement compared to other lesson plan models?", the majority (61) said YES, while only 3 said NO.

"Having seen LiGa, which of these editorial project structures could be incorporated into other didactic materials for greater clarity?" Responses on Figure 6:

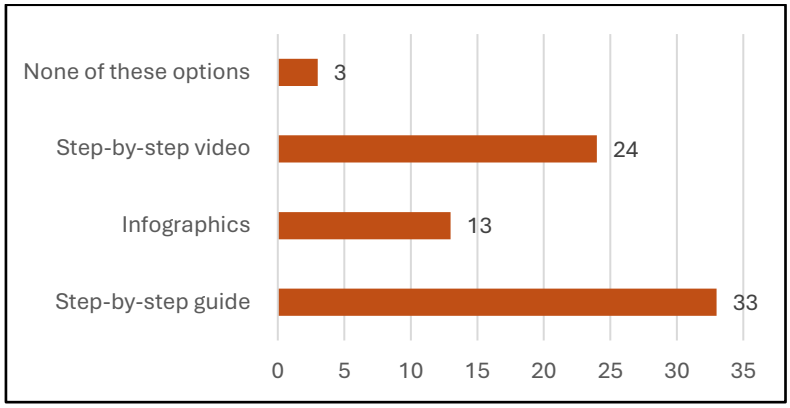

Figure 6 – Which LiGa editorial structure could be incorporated into other didactic materials.

3.3. Second workshop

The second workshop was held on May 29, 2024, with 80 teachers responding to the questionnaire, reflecting a higher participation rate possibly due to improved communication of the research's importance. At this point, teachers had been implementing LiGa for at least two months.

The System Usability Scale (SUS) was used to evaluate LiGa's usability. The SUS score was 49.84, as per the calculation referred to in section 2.2, indicating a neutral usability score. Full data can be accessed at: https://github.com/victorhprado/SUS-data-SBIE-2024-LiGa. Additional questions asked during this session included: "Which part of the editorial project structure do you most frequently rely on for clarifying implementation doubts? Check as many options as applicable". See Figure 6:

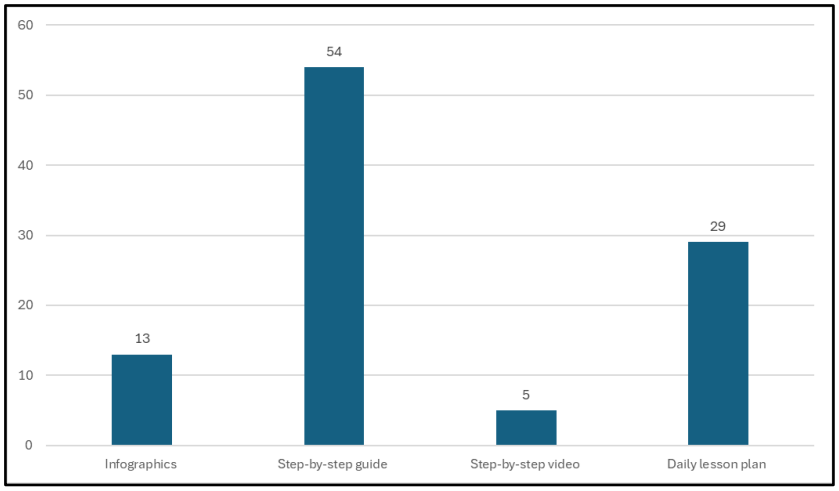

Figure 6 – Which part of the editorial structure is most used when in doubt.

Teachers were asked to assess the impact of LiGa on students using a Likert scale for the following questions, with average responses:

"I believe that students like LiGa" – 3.88;

"Students express that they would like to use LiGa in other subjects" – 2.9;

"The use of LiGa has increased students' attention in the subject" – 3.26;

"The use of LiGa has increased the dialogue between teachers and students" – 3.40.

An additional question, "After the implementation of LiGa, please indicate your perception of any observed changes in student behavior," Summarized answers on Figure 7

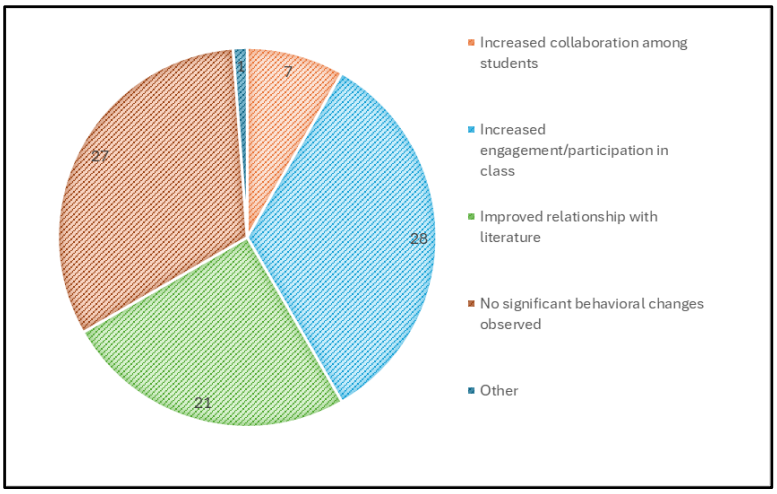

Figure 7 – Perception of changes in student behavior.

Excluding five double markings, 52 teachers perceived positive changes, compared to 27 who did not observe any changes.

Finally, regarding the completion of extra activities by students, see Figure 8:

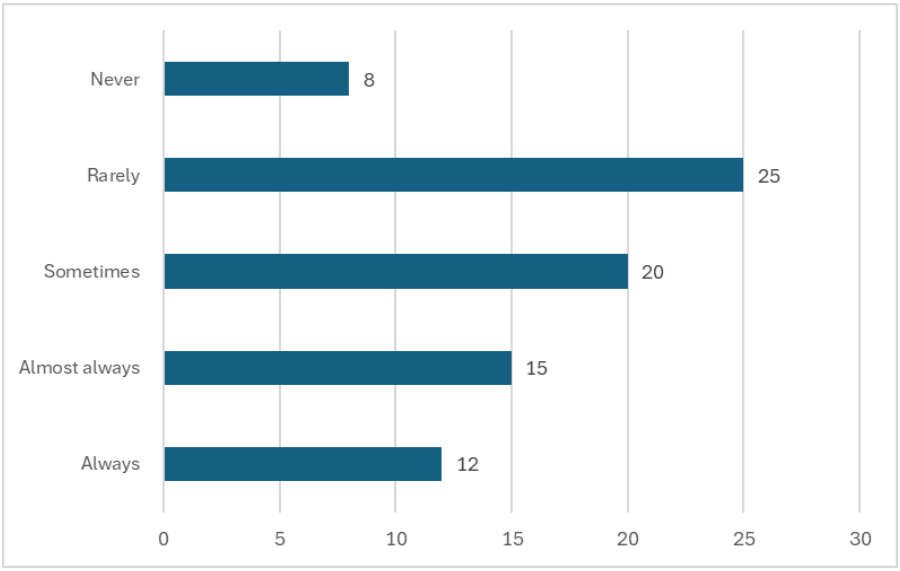

Figure 8 - Students completion of LiGa's extra activities.

The research methodology and findings provide a comprehensive understanding of the initial implementation and usability of LiGa, highlighting both its potential and the challenges faced in its adoption.

4. Results and analysis

This study focused on LiGa's usability and perceived results by teachers at this initial stage of implementation.

LiGa – Literature and Gamification was developed with usability and gamification concepts. The overall usability evaluation expectation for LiGa in this first implementation was low for several reasons. There is still considerable prejudice and resistance to the pedagogical use of digital entertainment games and their derived concepts, such as gamification. This perception tends to negatively impact the usability evaluation of these technologies since their very use begins with this bias. However, the results indicate that teachers perceived some positive changes in students' behavior after implementing LiGa. Many teachers reported that students appeared to enjoy using LiGa, which suggests that gamified strategies may have a role in engaging students and maintaining their attention. This aligns with other research suggesting potential benefits of gamification in educational settings. However, further research is necessary to confirm these findings and to explore any long-term impacts comprehensively.

Additionally, the perception of usability is influenced by the pioneering nature of the technology and the absence of established benchmarks for comparison (Rogers et al., 2019). This is particularly relevant for LiGa, as the research indicates that the material is significantly different from the didactic materials traditionally used by teachers in this network.

Another specific aspect of LiGa that might negatively impact its ease of use, is the lack of opportunities for repeated practice. Unlike digital technologies or traditional games that feature repetitive actions, LiGa's implementation is continuous and unique for each class. Each of the eight lessons within each gamification module has a distinct lesson plan, meaning teachers have only one chance to implement each lesson with their students. This lack of repetition reduces the opportunity for teachers to practice and refine their approach, potentially increasing the difficulty in understanding and effectively using the material.

Moreover, the model used to evaluate usability, the SUS, is not specifically designed to assess educational technologies. Although it is adaptable for this use, there does not seem to be other research employing this type of analysis for printed didactic materials (Vlachogianni & Tselios, 2022). Despite this, the overall SUS score was neutral, with other questions about LiGa's editorial project indicating that specific constructs of the material were well perceived and utilized for understanding.

The step-by-step guide emerged as the most effective structure for facilitating understanding of the material during both the first and second encounters. This guide serves as a simplified list of instructions, akin to those found in tabletop games, offering a clear and concise visual presentation. It includes all essential information regarding gamification elements without overwhelming the user with excessive detail. This distinction is crucial, as it ensures that implementation instructions are not conflated with the underlying pedagogical reasoning. By focusing on clarity and simplicity, the step-by-step guide can help educators quickly and effectively engage with the material, making it easier to implement and more accessible for teachers. Incorporating this type of guide into other didactic materials could significantly improve their usability, making complex content more accessible and easier to implement for educators.

5. Research and future directions

The ongoing implementation of LiGa in Itararé-SP offers significant opportunities to gain deeper insights into the adoption of the material by teachers and its impact on students'

formal performance. Conducting further in-depth research within the Itararé network could enhance our understanding of the network's perception of educational technologies similar to LiGa, particularly in terms of conceptual acceptance and practical implementation. This includes examining teachers' technological receptivity and their attitudes toward innovative educational tools.

Future academic studies on the implementation of LiGa in other educational networks can provide valuable comparative data, allowing for a broader analysis of results. Such studies could deepen the understanding of existing issues and identify new areas of inquiry. For example, it would be beneficial to explore whether the teaching culture of a small network, along with its willingness to embrace new educational technologies, influences the perceived usability of gamified didactic materials.

Considering recent trends, such as the prohibition of cell phones in schools and the post Covid-19 public policy stance against fully digital educational technologies, future research should focus on developing and proposing usability analysis models, specifically tailored for analog didactic materials. This approach would ensure that the unique characteristics and challenges of non-digital educational tools are adequately addressed, providing a comprehensive framework for evaluating their effectiveness and usability.

Such research directions not only promise to enhance the usability and effectiveness of LiGa but also contribute to the broader field of educational technology by offering insights into the successful integration of analog gamification strategies in diverse educational settings.

6. Acknowledgements

This work was carried out with the support of the Coordination for the Improvement of Higher Education Personnel - Brazil (CAPES).

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