Impact of the Use of Gamified Online Tools for Developing Logical Analysis Competences: A Study with Castor in the Educational Context

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***Abstract*—This study examines the impact of gamification on the development of logical analysis in computer science among secondary school students. Gamification, which involved the integration of game mechanisms into non-gaming contexts, is studied for its motivating effects and its influence on student learning. Moreover, the study addresses the underutilization of gamification to enhance problem-solving skills and logical thinking. The experimental study employs two variables: gamification as the independent variable and the development of logical analysis skills as the dependent variable. Furthermore, the methodology, grounded in a quantitative approach, involved a sample of 28 secondary school students. Tests were designed to assess students' difficulties in logical reasoning, and a certified test based on Howard Gardner's model evaluated different types of intelligence. The results demonstrate a significant improvement in student performance, particularly among those who face difficulties in analyzing problems or logical situations in computer science. Consequently, gamification emerges as an effective approach to boost engagement and enhance the logical-mathematical skills of secondary school learners. Additionally, the research identifies a correlation between logical-mathematical intelligence and students' performance in computer-related problem analysis, emphasizing the importance of logical thinking in problem-solving.**

***Keywords*—gamification, logical analysis, logical-mathematical skills, learning**

I. Introduction

In the contemporary era, technology has become pervasive in daily life. Consequently, the utilization of information systems is now imperative for performing a myriad of tasks. However, the integration of digital technologies within educational frameworks raises pertinent inquiries regarding their pedagogical efficiency [1]. Therefore, educators are compelled to substantiate the incorporation of these tools and their impact on learning to ensure they are not employed superficially but rather serve as genuine catalysts for students' educational advancement [2].

One innovative approach that educators are exploring is the incorporation of gaming concepts into education, representing a prevalent strategy aimed at bolstering student engagement and motivation. Since games are inherently intertwined with child development, they facilitate the creation of immersive and stimulating learning environments. This approach, coined as "gamification," denotes the application of gaming mechanisms within non-gaming contexts [3]. Originating within the digital media industry in 2008, gamification swiftly found resonance within the educational domain. The primary objectives of gamification in education are twofold: to motivate learners and to reshape behaviors such as knowledge acquisition and engagement with educational platforms [4]. As digital technologies permeate daily life, they become a channel for transmitting gaming mechanisms to learners, adding a motivational element to tasks and consequently contributing to student engagement.

Several studies have demonstrated the significant impact of gaming mechanisms on user behavior. For instance, the engagement and motivation of students to actively participate in a programming course have been positively influenced by gamification [5]. In this study involving 215 undergraduate students, the participants utilized a gamified tool in their programming course. The findings demonstrated that the gamified learning environment significantly enhanced students' motivation and engagement. The students exhibited increased willingness to participate in class, augmented self-confidence, and a more enthusiastic disposition towards academic pursuits. Additionally, they showed a proclivity for healthy competition with their peers and a greater inclination to learn from their mistakes.

In another study [6], researchers examined the effects of gamification elements—such as points, levels, and rankings—on intrinsic motivation and performance. The results indicated that while these elements can improve performance, they do not necessarily increase intrinsic motivation. Conducted on an image annotation task, the study revealed that although gamification enhances performance, its impact on intrinsic motivation is not significant. This suggests that it is crucial to meticulously examine how these elements are perceived by users, as gamification can enhance engagement and performance yet does not inevitably result in an increase in internal motivation.

Similarly, the beneficial effect of gamified Learning Management Systems (LMS) on online learner engagement was demonstrated in a study by Subiyantoro [7]. The objective of this study was to assess the impact of incorporating gamification elements—such as rewards, challenges, and leaderboards—into an LMS with the aim of enhancing student involvement. Through a series of experiments, the researchers evaluated the efficacy of these gamified elements in terms of student engagement and motivation. The findings indicated that the incorporation of these elements into the LMS significantly enhanced student engagement, participation in learning activities, and overall perseverance. This study underscores the importance of utilizing gamification as a strategy to enhance the appeal and interactivity of e-learning, highlighting the necessity of designing LMS platforms that seamlessly integrate game elements to optimize student engagement and improve academic outcomes.

Despite the positive findings in previous studies, there remains a paucity of practical applications and scholarly inquiry regarding the utilization of gamification for fostering problem-solving skills and logical reasoning. Consequently, this study aims to examine the potential of gamification in promoting analytical thinking for computer-based problem solving among secondary education students through experimentation.

II. Literature Review

A. Gamification

Previous research in the field of educational games has extensively examined motivation and its impact on individuals' and groups' behavior with the aim of producing the desired effect. The positive effect of gamification in encouraging individuals to engage in activities that would otherwise be boring or difficult has been highlighted, with the aim of motivating them to improve and surpass themselves [8, 9]. Furthermore, it underscores the beneficial impact of gamification [5].

Research on games has demonstrated the significance of players' motivational and emotional engagement. Gamification, as an approach, seeks to leverage the motivational power of games for purposes beyond mere entertainment. Recent research has demonstrated the impact of mathematical video games on learner motivation and engagement. Researchers conducted a study to analyze the effects of video game use on a sample of learners. The study highlighted associations between gaming, intrinsic motivation, and student engagement in mathematics learning. The findings offer intriguing insights into the potential of video games as a pedagogical tool for fostering learners' motivation and engagement in mathematics [10].

Another study has demonstrated that the incorporation of gamification into language learning has a positive impact, particularly among children and teenagers. Those who used the gamified version of Duolingo, which incorporates mechanisms such as points, badges and rankings, achieved better results than those who used the non-gamified version [11].

It is also important to note that researchers have identified potential negative effects of gamification, including frustration and pressure. Moreover, the efficacy of gamification can vary contingent on the context and type of user. Conversely, the incorporation of gaming elements into the educational context has emerged as a promising strategy for enhancing student engagement and participation. Specifically, this method provides a means of enhancing the engagement and motivation of learners in educational activities [12]. Nevertheless, to ensure its effectiveness, it is crucial that game design is well thought out and realistic. Consequently, this underscores the importance of the financial and pedagogical resources required for implementing this approach, as well as the need for a shift in teachers' mindset and attitude, given that learning is traditionally perceived as a serious activity. Despite the potential benefits of gamification, further research is necessary to confirm its effectiveness and identify the most effective gaming mechanisms for motivating learners in different educational contexts.

Motivating learners can also harness the potential of artificial intelligence. A study on the integration of AI in mathematics education in schools in the Emirate of Abu Dhabi showed that AI tools can improve teaching effectiveness and student performance by introducing elements of motivation, challenge, and personalized learning. However, teachers face challenges such as extra effort and external pressures. The study suggests that these findings could be used to guide the integration of AI into educational environments [13].

B. Logical Reasoning and Gamification

Logical reasoning is a complex cognitive process that involves understanding logical relationships, identifying premises, drawing conclusions from arguments, and solving logical problems [14]. Research has shown that these skills are essential for academic success, and pedagogical strategies often recommend beginning with simple activities and gradually increasing their complexity [15]. Fayol emphasizes that logical reasoning is crucial not only for specific problem-solving but also for the development of critical and analytical thinking. However, his study has been criticized for lacking sufficient empirical data and concrete examples of successful pedagogical interventions. While the importance of logical reasoning is clear, the integration of these skills into curricula remains somewhat vague, and more evidence is needed to demonstrate their effectiveness in practice. Additionally, an overemphasis on logical reasoning might neglect other essential skills, such as creativity and socio-emotional abilities, which are also important for well-rounded academic success. A more balanced approach that considers a wider range of skills could enhance the study's findings.

Research on gamification and its impact on logical reasoning and motivation presents a complex view of both the benefits and challenges of this approach. Alsawaier [16] highlights the promise of gamification in increasing student motivation and engagement but points out the gaps in practical implementation and the need for more empirical research. Manzano-León [17] also supports gamification's positive effects on student motivation and performance but calls for further research to address specific challenges in gamified learning environments. Kayali [18] affirms the effectiveness of gamified tools in developing logical reasoning among software practitioners, although the study's narrow focus may limit its applicability to broader educational contexts. Similarly, Silva [19] and Tsalapatas [20] advocate for gamification in early education to teach logical reasoning, but they emphasize the need for well-designed, context-specific tools to achieve educational goals. Overall, while gamification shows significant potential, its successful implementation requires careful consideration of learner needs, empirical validation, and practical guidelines to bridge theory and practice.

C. The Relationship between Types of Intelligence and Logical Thinking

Previous research has demonstrated that primary school students with high logical-mathematical intelligence have better logical thinking abilities, particularly concerning understanding logical relationships, identifying premises and conclusions of an argument, and solving logical problems. It follows that students with high levels of logical-mathematical intelligence achieve superior results in these subjects, especially concerning understanding scientific concepts, mastering mathematical procedures, and problem solving. Empirical studies have established a significant correlation between logical-mathematical intelligence and students' performance in mathematics as well as in science at the secondary level [21–23].

The study is based on the use of gamification as a motivational driver to increase learner engagement in learning computer programming concepts through a gamification framework. The first hypothesis posits that gamification as a pedagogical approach facilitates the development of logical-analytical thinking, especially in solving computer programming problems, in secondary school students. Additionally, the relationship between the level of logical-mathematical intelligence and the performance of individuals in analyzing logical problems or situations in computer science is of interest. The second hypothesis postulates that logical-mathematical thinking affects the capacity of high school students to reason logically and deduce effectively.

III. MATERIALS AND METHODS

The methodology employed in this study is based on the quantitative approach, which entails the collection and analysis of quantitative data. This method is useful for measuring phenomena and quantifying relationships between different factors [24]. This approach enables the production of aggregated results in the form of percentages or averages, as well as the identification of links between variables.

Once the objectives to be evaluated and developed in learners have been defined, a test is implemented with the aim of identifying the difficulties encountered by students in the field of logical reasoning, particularly in relation to computer-related problems. Subsequently, a comprehensive analysis of the results is conducted, taking into account the various types of intelligence exhibited by each learner, using a certified test based on Howard Gardner's model. This model has been validated by several researchers, including [16], who found the test to be reliable and valid for children, adolescents, and adults. The test assigns a score to each type of intelligence according to a well-defined grid. The test is administered in the form of a questionnaire comprising 70 questions, with 35 reserved for individuals aged 8 to 16 years. Given that the test was originally designed in English, it was deemed appropriate to translate it into French in order to facilitate student comprehension and obtain accurate answers. The translation process is illustrated in Fig. 1. A summary of the multiple intelligences model is presented in Fig. 2.

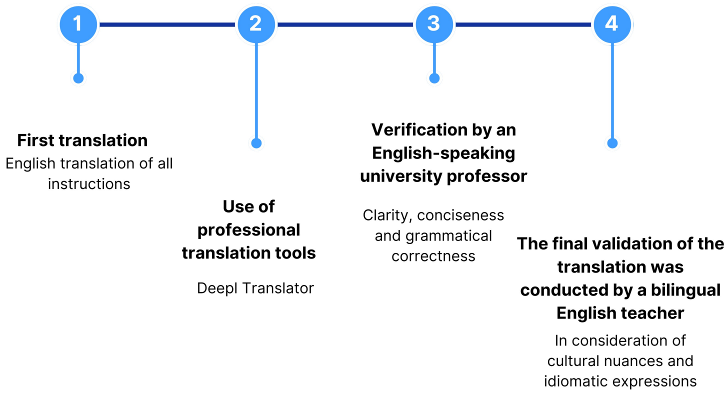

Fig. 1. The translation process.

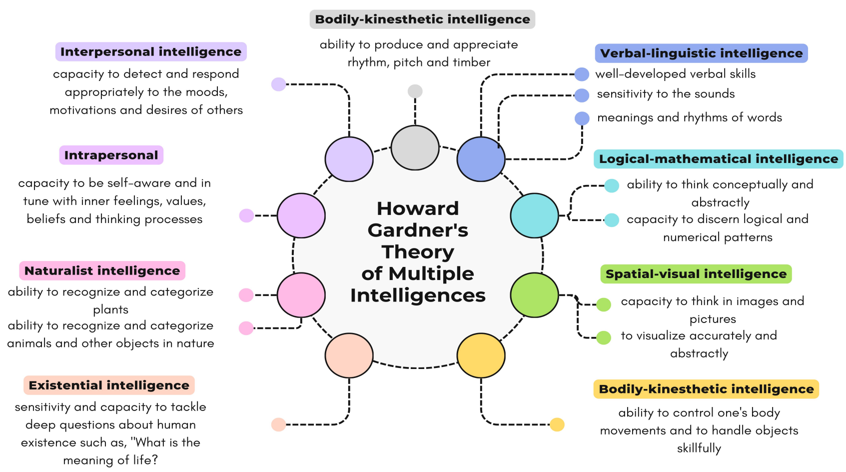

Fig. 2. Howard Gardner's model of multiple intelligences.

Five training sessions (240 minutes for each) are then conducted on a gamified platform, tailored to the previously identified needs of each learner based on the objectives of the logical model from the initial test. These sessions are supervised by a computer science teacher. The following explains how these games were introduced and how their use in the classroom was managed. Refer to Table 1 for further details.

The present study delineates two variables: the independent variable, which is gamification, and the dependent variable, which is the development of logical analytical skills for computer problem solving. To assess participants' performance before and after the implementation of gamification in the classroom, an experimental study was conducted to examine the relationship between variations in these performances and students' multiple intelligences according to Howard Gardner's model (see Fig. 3).

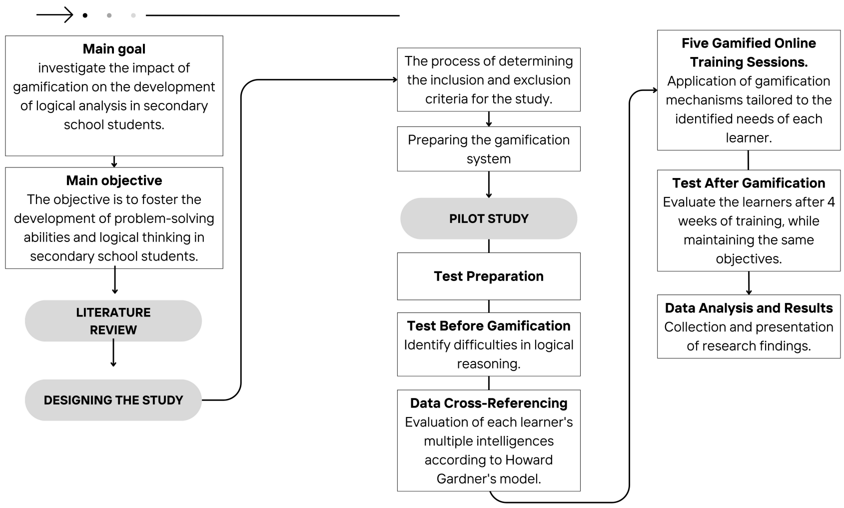

Fig. 3. A general overview of the methodology employed in the study.

Table 1. The integration of gamified activities into the classroom

Total duration	20 hours (total for 5 training sessions)
Session objective(s)	To address and solve individual problems involving various aspects of computing, including: Knowledge of decrementing. Knowledge of incrementing. Understanding the concept of loops. Understanding the concept of variable assignment Detecting logical rules through tests. Mental calculation.
Tools	Computers with internet access, Video projector, The Castor platform.
Session sequence	Introduction to the Platform: The teacher demonstrates the platform homepage and explains the procedure for practising on the platform. Introduction to the Games: The teacher presents the games and their rules, emphasizing that completing at least the first level unlocks additional games. Scoring System: The teacher explains that students earn points for each level they complete, with each game containing three levels. Distribution of Instructions: An instruction sheet is distributed to each student, summarizing the steps to begin the training and offering strategic advice. Independent Practice: Students independently work on the exercises for 45 minutes per session. The platform generates a unique identification code for each student, retained throughout the training. Assistance During Gameplay: While students engage with the games, the teacher circulates among them to assist with understanding the instructions and selecting effective strategies to unlock the current level.
Training	Each student follows the outlined steps using the provided instruction sheet to access the training sessions. At the conclusion of the session, the teacher records the points scored by each student and projects the ranking list to encourage continued involvement in the subsequent phases of the experiment.

A. Proposed Evaluation Sections Implemented in Castor Informatique

The games available on the Castor platform share several common features. Primarily, they are individual puzzle games. They have the particularity of being progressive, with three levels of difficulty to facilitate the pedagogical method of learning the mechanics of each game. Consequently, they are suitable for different age groups, depending on each player's level. Secondly, the rules are simple to understand and memorize. Finally, these games are primarily designed for entertainment, and the scenarios are of good quality. In the form of challenges, they can serve as a motivating force for players as they strive to advance as far as possible.

The Castor platform offers a variety of games, and those that aim to address the shortcomings identified in the initial test have been selected. These shortcomings are generally those indicators that were not validated by the students according to the evaluation grid.

- The game "Shape Language"

Comprises a game plan, several shapes, and a space to arrange the shapes according to the code announced by the player and describing the design. The rules of the game permit timed competition between two players, with each player taking turns to play the same challenge. The objective of the game is to move each shape on the game board, respecting the code that describes each drawing, thereby enabling learners to acquire the ability to relate two distinct objects. The game comprises three challenges, each divided into three versions (levels). Each version represents an increase in complexity.

- The games “Infernal Tower”, “Crane control” and “Fantome”

The Infernal Tower game is also available on the Castor platform. The objective of the game is to place the blocks as shown on the target. The game has its own rules, notably concerning the number of steps required to move the blocks. To obtain the maximum number of points, it is necessary to complete the challenge with the fewest possible steps. The other two games (Crane Control and Fantome) have the same objectives as Infernal Tower and enable students to develop the ability to identify a logical rule to complete the challenge.

- The “Broken Totals” game

Is designed to challenge students’ memory and mental calculation abilities. The objective of this game is to enhance students’ memory and promote the performance of mental calculations. The fundamental principle of the game is straightforward: a table containing an error is provided, and based on the sum of the white cells in a row or column, which must always be correct, the players can modify the table to have a correct sum on both sides.

- The “Vegetable Selection” game

Is designed to facilitate the acquisition of knowledge and skills related to the selection of vegetables. The objective of this game is to educate students on the concept of variable assignment and the use of conditions (IF...THEN). The fundamental principle of this process is the filtering of a pre-filled list in order to obtain a desired list that corresponds to the statement in question. Conditions are employed through drop-down lists to establish the requisite criteria for achieving the desired result. Furthermore, the concept of variable assignment is employed to link the type, color, and image of an object. The game comprises three versions, with the difficulty of the subsequent level increasing in accordance with the student’s performance in the previous one.

A similar principle is employed in the “Colored Signals” game, which also teaches students the concept of variable assignment. The fundamental principle of this methodology is the assignment of colors to words in accordance with the model proposed in each statement. This is followed by the identification of sequences of colored signals and the validation of all possible combinations.

- The “Distance” game

Guess which squares Castor can reach with two or three steps. Based on the diagram, which gives hints about the points Castor can reach with certain steps. Start by marking all the squares at distance 1 from the starting point, then all the squares at distance 2, then 3, and so on. Once the squares are marked, it’s easy to figure out how to get to the starting point (at distance 0) as quickly as possible: just go for the smallest numbers. This helps students understand the concept of incrementing and decrementing.

- The “Reproduce a drawing” game

Its goal is to teach the concept of loops and the use of variables. The principle is to write a program using instructions. These instructions are systematically repeated.

The activity type section proposed in this research is designed to assess students’ performance in different cognitive domains. It includes a variety of activities designed to stimulate different skills, from solving logical problems to mastering basic computer concepts. Each activity is carefully selected for its ability to engage students and help them develop specific skills as presented in Table 2. This approach allows for a holistic assessment of student performance, providing valuable data to inform pedagogical practice and identify areas that need additional support.

Table 2. Sections proposed to evaluate student performance on the castor Informatique platform

Activity	Objective
Shape Language	Establishing the relationship between two distinct objects
Crane Control	Control Ability to find logical rules
Fantome	Ability to find logical rules
Broken Totals	Totals Mental calculation
Vegetable Selection	Understanding the concept of variable assignment Use of conditions
Colored Signals	Understanding the concept of variable assignment
Distance	Decrement and Increment operations
Reproduce a Drawing	Understanding the concept of loops
Infernal Tower	Ability to find logical rules

B. Evaluation Grid for the Two Tests

The evaluation grid used in both tests (before and after implementation of gamification elements) is designed to assess several key criteria related to students’ performance in logic. Each criterion is assessed on a specific measurement scale, with a weighting assigned to each element. A specific acceptance threshold is defined for each test, indicating the minimum score required to consider students as having passed the test.

The evaluation grid thus provides a clear structure for assessing students’ performance in different areas of logic, providing specific indications of observable objectives to be achieved. It also allows for the comparison of students’ performance before and after the integration of gamification, thus providing valuable data on the impact of this pedagogical approach on students’ outcomes. As can be observed in Table 3.

Table 3. Evaluation grid for the two tests

Evaluation Criteria	Observable Objectives	Measurement Scale		Weight
Alphabetic Sequences	Knowledge of decrementing	1	…/4	…/6
	Knowledge of incrementing	1		
	Understanding the concept of loops	1		
	Understanding the concept of variable assignment	1		
Numeric Logic	Tests Detecting logical rules	1	…/2	
	Mental calculation	1		
Acceptance Threshold:	**04 /6**			
Judgment:	Validate			Not Validate

The acceptance threshold in the table is set at 4 out of 6, which is the minimum level of performance required to be considered satisfied. Here is the explanation for setting this threshold:

Weighted Criteria: Each observable objective within the evaluation criteria is assigned a weight. The criteria include:

Alphabetical Sequences: This criterion consists of four sub-objectives, each weighted at 1 point.

Numerical Logic: This criterion consists of two subcriteria, each weighted at 1 point.

Total Possible Score: The total possible score across all observable objectives is calculated as follows:

- Alphabetical order: 4 sub-targets × 1 point each = 4 points.
- Numerical Logic: 2 sub-objectives × 1 point each = 2 points.
- Total possible score = 4 points (Alphabetic Sequences) + 2 points (Numerical Logic) = 6 points.

The threshold of 4/6 is set to ensure that students demonstrate a satisfactory level of understanding and competence in most of the observable objectives. Specifically, a score of 4 out of 6 means that students have successfully completed at least two-thirds (approximately 67%) of the total measurable objectives.

Setting the threshold at 4/6 provides a balanced assessment by not requiring perfection but still ensuring that students have a solid understanding of key concepts. This approach allows for some minor errors or gaps in knowledge while still indicating overall proficiency.

C. *Population and Sample*

The study population was selected by judgmental sampling. This method involves choosing individuals to study based on criteria predetermined by the researcher. The criteria used in this study are based on prior knowledge of the composition and behavior of the population. The two classes selected for the experiment have already been introduced to the fundamental concepts of programming.

The sample consisted of 28 secondary school pupils from the school in question (a school group located in the Rabat-Salé-Kénitra region of Morocco), representing 55% of the school's total student body (mean age = 13.36; SD = 0.49). The sample included 13 girls (46.42%, mean age = 13.31; SD = 0.47) and 15 boys (53.57%, mean age = 13.37; SD = 0.49).

These students are in the 2nd year (Mean age = 13; SD = 0) and 3rd year (Mean age = 14; SD = 0) of secondary school who were chosen because the theme of the experiment requires students already initiated in basic concepts of computer programming.

D. *Data Analysis*

The research data obtained underwent a comprehensive analysis (enabled), employing both descriptive and inferential analysis methods. The data collected can be classified into three distinct categories. Firstly, the results of the pre-gamification integration test in the classroom were analysed in order to identify the specific shortcomings of each learner in relation to the objectives addressed. The objective was to identify the most suitable games to meet the individual needs of each student. Subsequently, the test evaluating the multiple intelligences of the students, according to Howard Gardner's model, was examined to determine if the logical-mathematical intelligence type influences students' logical analysis skills. Finally, a post-test was conducted four weeks after the implementation of the gamification approach on the Castor Informatique platform. This second test followed the initial test and the training sessions, allowing for a comparison of results to assess the impact of the gamification approach as a remedial tool for students struggling with subjects that require in-depth logical analysis.

This analysis allows for the evaluation of the quality and relevance of the approach and content presented on the *Castor Informatique* platform. It also provides insight into the relationship between logical-mathematical intelligence and the ability to solve complex logical problems.

IV. Result

Given that the gamification-based learning approach influences student motivation, the distribution of the data does not follow a normal distribution. Consequently, the Wilcoxon test is employed to test the first one-tailed hypothesis. The results of the data rank analysis (Wilcoxon) indicated a statistically significant difference in student performance before and after the implementation of gamification ($p < 0.001$). As illustrated in Table 4, all students who demonstrated difficulty with the concepts addressed in the initial assessment were able to overcome these challenges through the implementation of gamification.

Table 4. Wilcoxon test result

Paired Samples T-Test				
			Statistic	**P**
Test before gamification	Test after gamification	Wilcoxon W	0.00*	< .001

The results of the multiple intelligences test, as defined by Howard Gardner's model, indicated a preponderance of logical-mathematical thinking among the students who passed the initial assessment, while the other students who did not pass the test exhibited a notable deficiency in their sensitivity to the logical patterns presented in the initial assessment. The students demonstrated a deficiency in deductive reasoning abilities, analytical thinking, and the ability to synthesize information in general. These students demonstrated the utilisation of a range of intelligences, with a relatively low density of logical-mathematical intelligence. It is also noteworthy that all students exhibited a minimum level of intrapersonal intelligence. As illustrated in Fig. 4.

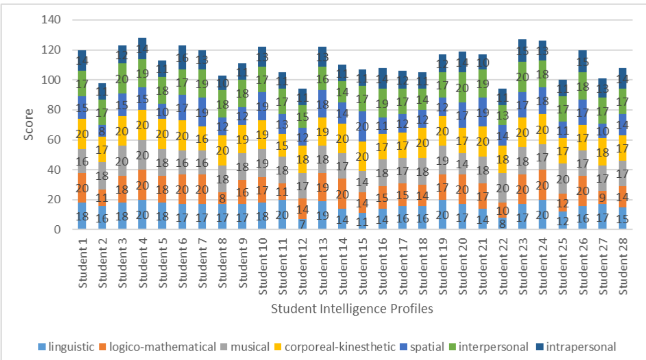

Fig. 4. Student intelligence profiles: Gardner's model.

The results of the curves in Fig. 5 indicate that, following the implementation of gamification, all students achieved a higher percentage of correct answers across all questions in the second test compared to the first test conducted prior to the introduction of gamification. Moreover, it is evident that students encounter difficulties when confronted with logical patterns that necessitate the application of advanced cognitive processes, such as strong mental analysis and logical thinking. This is evidenced by the results of the mental calculation objective, which demonstrated a success rate of 35% prior to the integration of gamification, in contrast to an 82% success rate following its implementation. Consequently, it can be observed that all students exhibited an improvement in their performance, with an increase of 53.6% between the initial and subsequent assessments.

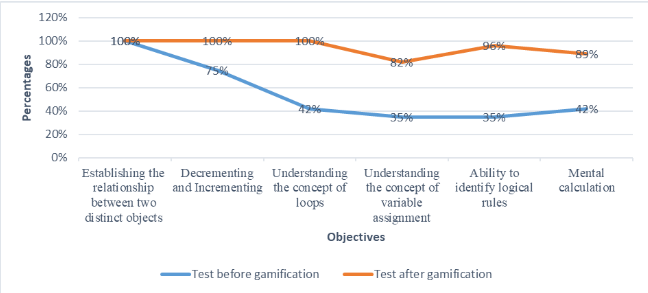

Fig. 5. Comparison curve of response percentages per objective between the two tests.

V. Discussion

The present study examined the impact of gamification on students' performance and their multiple intelligence profiles, as defined by Howard Gardner's model, through the use of the Castor platform. The objective of the research was to expand understanding of the motivational potential of gamified activities, demonstrating that they can spark students' interest in learning. Moreover, students who did not pass the initial examination demonstrated deficiencies in their ability to perceive logical patterns and engage in deductive reasoning. The Howard Gardner multiple intelligence test also indicated a deficiency in logical-mathematical thinking, which served as a complete mediator between the concepts addressed and the method of deducing the answers to validate the latter. The results demonstrate that all students experiencing difficulty with the concepts addressed in the initial assessment were able to overcome their shortcomings through the implementation of gamification. This evidence suggests that gamification can be an effective strategy to assist struggling students in their academic progress. The incorporation of game elements, such as points, badges, and interactive challenges, creates an engaging learning environment that motivates students to participate actively and persevere in their efforts. By transforming traditional learning activities into more dynamic and enjoyable experiences, gamification taps into students' intrinsic motivation, making them more willing to engage with difficult material. Furthermore, the data indicates that the structured use of gamification helps in breaking down complex logical and analytical problems into manageable tasks. This step-by-step approach can significantly enhance a student's ability to comprehend and apply difficult concepts, which traditional methods may fail to achieve effectively. Moreover, the incorporation of gamification into learning environments often encourages collaboration and peer support, fostering a community of learners who assist each other in overcoming obstacles and sharing strategies for success. Finally, it is notable that all students exhibited a minimum level of intrapersonal intelligence. This could be attributed to the fact that these students are still young and developing, which may influence their self-awareness, self-knowledge, personal objectivity, and relationships with others and the world. Furthermore, the use of games to gamify a learning activity does not fundamentally alter students' skills if it is used without a specific objective. The selection of gamification techniques must be appropriate and aligned with the desired outcomes. In conclusion, the findings indicate that gamification has a positive impact on students' performance, particularly those facing challenges, and can contribute to strengthening the logical-mathematical skills of secondary cycle learners.

VI. Conclusion

The existing literature highlights the potential of gamification to energize learning environments. The effectiveness of a gamification system depends on both its intrinsic quality and how it is used and integrated into a specific context. With this in mind, the case study conducted by Brassier examined the practical applications of gamification in international business training.

The results of this study demonstrated that integrating game mechanisms into pedagogical activities enhanced student involvement and satisfaction, while fostering the development of transferable skills such as problem-solving, decision-making, and intercultural communication. These findings align with the conclusions of this study.

Nevertheless, an analysis of the data collected as part of this study also revealed the necessity of meticulously selecting gamification devices according to the objective of the activity to be gamified in order to maximize its positive impact. Moreover, the implementation of a gamification system necessitates a considerable investment of effort, which may not be justified if the selected approach is not optimal. To enhance comprehension of the pedagogical advantages of gamification, it would be advantageous to conduct further analogous studies, exploring the utilization of distinct gamified devices across a spectrum of educational settings. Such research could facilitate the identification of optimal methodologies for effectively integrating gamification into the classroom.

VII. Limitations and Futures Recommendations

The limitations of this research primarily include the exclusive focus on the application of gamification in the educational domain without a more thorough exploration of other potential areas. Additionally, the study does not account for individual variations among students in terms of their reactions to gamification, which could restrict the generalization of the results. Moreover, the research is confined to the use of a single gamification platform, which may limit the scope of the conclusions for other contexts or platforms. To address these limitations, it is recommended to broaden the research to explore the effects of gamification in various contexts and on diverse age groups, as well as to incorporate qualitative measures to complement the quantitative findings. Furthermore, it is important to examine the long-term impact of gamification on the development of problem solving skills in learners, to develop ethical guidelines for its use, and to explore alternative gamification mechanisms to mitigate potential adverse effects.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Y. Karroumi conducted the research, analyzed the data, and wrote the paper; F. Ou-zennou, K. EL Khattabi, and S. Eddarouich proofread and finalized the article. All authors had approved the final version.

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