ISSN 1982-5587

Research articles

Motivation and gamification: the effect of gamification in high school

Motivação e gamificação: o efeito da gamificação no ensino médio

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HOW TO CITE: RIBEIRO, M. D.; VERSUTI, F. M. Motivation and gamification: the effect of gamification in high school. **Revista Ibero-Americana de Estudos em Educação**, Araraquara, v. 21, e20504, 2026. e-ISSN: 1982-5587. DOI: https://doi.org/10.21723/riaee.v21i00.2050402

Abstract

Educational literature suggests that gamification may increase students' engagement in school activities. However, there is little evidence regarding its effects on motivation to learn. This research investigated whether gamification influences the motivation to learn of high school students. The High School Motivation to Learn Scale (HSMLS) was applied before and after interaction with a digital game developed for the study. The interval between applications was 30 days. During this time, students in group A played the game, while those in group B (control) did not take part in the experiment. In total, 135 students took part, 99 in group A and 39 in group B. The results showed that, despite the high engagement and satisfaction with the gamified activity, there was no increase in the participants' motivation to learn.

Keywords: gamification; motivation to learn; engagement in activity; high school.

Resumo

A literatura educacional sugere que a gamificação pode aumentar o engajamento dos estudantes em atividades escolares. Contudo, há poucas evidências sobre seus efeitos na motivação para aprender. Esta pesquisa investigou se a gamificação influencia a motivação para aprender de estudantes do ensino médio. Para isso, utilizou-se da Escala de Motivação para Aprender para Alunos do Ensino Médio (EMA-EM), aplicada antes e depois da interação com um jogo digital desenvolvido para o estudo. O intervalo entre as aplicações foi de 30 dias. Durante esse período, os estudantes do grupo A jogaram o jogo, enquanto os do grupo B (controle) não participaram da experiência. No total, 135 estudantes participaram, sendo 99 no grupo A e 39 no grupo B. Os resultados mostraram que, apesar do alto engajamento e satisfação com a atividade gamificada, não houve aumento na motivação para aprender dos participantes.

Palavras-chave: gamificação; motivação para aprender; engajamento na atividade; ensino médio.

INTRODUCTION

Alternative resources that move away from traditional teaching methods and appear to generate motivation for learning have been the subject of study in recent years. Gamification, and the use of game elements to modify behaviors by increasing engagement in tasks proposed in the classroom, has been widely studied and applied in the educational context with the aim of increasing motivation and, consequently, enhancing learning.

Despite the use of gamification in educational settings, there are still unclear aspects related to its design features. These may work differently depending on the educational environment. Likewise, it is important to investigate which affective and cognitive processes are associated with games and respond positively to them (Legaki et al., 2020).

Motivation is what drives people to achieve their goals. Based on Bandura (2001), it is possible to understand motivation as a result of three dimensions: previous experiences + emotions + cognition. From these three factors, the motivating beliefs for behavior are generated. In this conception, the motivation to learn is related to the beliefs of the students, that is, with the

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Submitted: August 12, 2025
Reviewed: February 14, 2026
Approved: February 14, 2026

Financial support: CNPq and FUSP.

Conflicts of interest: There are no conflicts of interest.

Ethics committee approval: CAAE nº 44276721.5.0000.5407.

Data availability: Research data are available in the body of the article. Study conducted at Universidade de São Paulo (USP), Ribeirão Preto, SP, Brasil.

sum of previous experiences, and how the person perceived their efforts in relation to their results throughout life.

Behaviors presented in pursuit of an objective or goal are triggered by factors other than those presented. Anticipatory thinking (Bandura, 1997), for example, essential for the ability of predicting future consequences according to the current context analysis, is one of the indispensable factors for motivation to occur. Another important factor mentioned by researchers investigating emotions is the relevance of emotions when experienced in context analysis, repertoires of previous successful behaviors that may or may not be triggered. Depending on the emotional relevance, given the current situation, the sedimented beliefs may be used in the decision-making process regarding actions, or simply ignored (Dukes, 2021). Therefore, decision-making regarding behavior is carried out according to the emotional relevance given to the experienced context.

For example: a 16-year-old student needs to study for an exam; however, he was asked out by the girl he likes the most in the afternoon he had reserved for his studies. As much as he knows the importance of studying for the test, going out with the girl is what he wants most, and refusing the invitation would be much worse than getting a poor grade on the test. In this example, his emotional relevance is given exclusively to the activity of going out with the girl he likes, and it is quite likely that he will decide to go out with the girl at the expense of performing well on the test. However, he may decide to decline the invitation and study for the test, which can lead to low performance in the chosen activity due to cognitive dissonance. Depending on the emotional self-regulation of the student in question, he may not want to give up any of the possibilities and decides to invite the girl to study with him. In this scenario, common in the daily lives of adolescents, decision-making resulting in behaviors that may or may not favor their academic performance is much more driven by the emotions involved in the situation, than by the perception that studying is important to have good academic results.

Therefore, motivation, including motivation to learn, involves complex and relative aspects, with several variables. Furthermore, the countless studies aimed to map these variables are justified by the need to identify possibilities of intervention in the school context in order to increase the meaning of students' learning, as well as to help them make better decisions. Based on the above, metacognition, with the dissemination of the most effective strategies for self-regulation in learning, faces limitations, including in the cases of adolescents who deal with scarcity and more difficult realities. Many other factors will have greater emotional relevance to the detriment of learning.

New studies recognize that people, in general, fulfill numerous tasks, not only being motivated by internal factors, but also by obligation or encouragement to achieve rewards, or avoid punishments. Thus, understanding motivation as a *continuum* (Deci; Ryan, 2004) is better than defining it by its motivators (elicitors), since it may range from total demotivation regarding an activity through external regulators (performing the activity to have approval or acceptance from teachers, parents, and/or social guidelines), to the achievement of intrinsic regulation (performing the activity because one has seen it as meaningful and important). This *continuum* of Self-determination Theory is defined in different stages according to how much motivational beliefs are related to external requirements and/or to internal requirements or values:

1 - motivation by pure **external regulation**: the person performs the activities to receive external rewards or avoid punishment;

2 - motivation by **introjected regulation**: external punishments or rewards do not exist, but an internal psychological pressure has been built up in which actions take place to avoid guilt or shame, or for self-referential reasons;

3 - motivation by **identified regulation**: a state in which the person internalizes the social values associated with the action, being able to relate to them;

4 - motivation by **integrated regulation**: the activity to be carried out is consistent with the values of the person.

Therefore, there is the possibility that academic activity, as well as other activities, start from a stage of total demotivation (without any reason for its action), being influenced by extrinsic regulators (when the activity is performed to fulfill environmental requirements), possibly

remaining that way, or eventually shifting to being influenced by intrinsic motivators (when there is pleasure in executing the activity that was previously only done for external rewards). This view of motivation as a *continuum* reinforces that autonomous motivation is present when motivation is triggered by both extrinsic and intrinsic motivators (Deci; Ryan, 2004).

Understanding motivation as a *continuum*, incorporating activity and environments that trigger emotional relevance favorable to engagement in the activity offered may be a way to increase motivation, considering that academic reality, no matter how carefully prepared and with clear strategies for self-regulation in learning, by itself, is often emotionally irrelevant for adolescent students. This does not mean that everything should be planned in order to generate emotional relevance, but considering making the environment more playful and lighter in the midst of content with little meaning for students and/or little importance in everyday life in the medium and long-term is an alternative.

The motivation to learn is the objective to be sought by teachers with respect to their students, that is, motivation in the academic context. Scholars of motivation to learn defend the possibility of developing and maintaining motivation to learn from academic activities. In order to do so, the activities must be perceived by students as meaningful and deserving of engagement. In other words, the ability to predict positive future events that articulate one's present actions is what leads to the motivation to learn. From this perspective, the motivation to learn is directly linked to the definition of goals and objectives and the way in which the student plans and executes the actions to achieve them (Printrich, 2004; Boruchovitch; Bzuneck; Guimarães, 2010; Bzuneck, 2018).

Known as goals and achievements theory, this approach seeks to understand what students' personal beliefs are and their connections to academic goals. This theory is tied to Self-determination Theory, in which students' beliefs about motivation to learn are the result of how they understand their experiences of success and failure. It means that, if they interpret their failures as surmountable challenges, they increase their efforts, but they become discouraged if they see their failures as indicators of personal deficiencies, or if they believe that they are being exploited, coerced, disrespected, or manipulated. Following this train of thought, it is believed that the more students perceive their effort as a generator of positive results in the academic context (perception of self-efficacy), the greater their motivation in planning and carrying out the activities is, favoring better performances (Boruchovitch; Bzuneck; Guimarães, 2010).

Knowing about the students' reasons and beliefs is relevant. However, the greater focus of these studies is on the cognitive aspects of the students, rather than on the situational context itself and on what emotions these academic contexts trigger. For Social Cognitive Theory, most motivation is generated in cognition (Bandura, 1997). Nevertheless, affective processes (emotions, feelings, motivations, moods, or attitudes) drive behavioral and cognitive processes, such as attention, learning, memory, and decision-making (Labar; Cabeza, 2006; Lerner et al., 2015; Phelps, 2006; Pool et al., 2016).

Considering that the characteristics of both the strategies used and the environmental arrangements may generate emotional relevance for the students, contributing or not to the engagement in the activities, it is necessary to differentiate motivation to learn from engagement in the academic activity/task: motivation to learn consists of an underlying psychological process, referring to the energy, direction and reason of a given behavior; it involves why students do what they do. Engagement consists of energy in action; it corresponds to the connection between the person and the activity (Russell; Ainley; Frydenberg, 2005; Ainley, 2012). Unlike the conceptualization of motivation to learn, it is not necessary to attribute meaning or value to achieve engagement in activities, since the student engages in an activity when its contextual factor triggers positive emotions such as interest, fun and contentment (Ainley, 2012). Likewise, students who are motivated to learn and who attach value to the learning process itself do not necessarily engage in all activities. Motivation is necessary for engagement in the task, but it is not enough.

Several articles, despite addressing the benefits of gamification, citing its effects on students' motivation and engagement, do not adequately define these two constructs, nor cite their differences. Due to the lack of consensus regarding the boundaries of this concept, researchers

have resorted to adopting constructs from other theories to address students' engagement in the classroom (Boekaert, 2016; Fredricks; Filsecker; Lawson, 2016). The most widely used theory is the one proposed by Fredricks, Blumenfeld and Paris (2004), which conceptualizes engagement in three dimensions:

1 - Behavioral engagement: refers to students' external behaviors, such as task completion, active participation, attendance at classes and the absence of inappropriate behavior.

2 - Emotional engagement: involves students' internal emotions, such as anxiety, boredom, happiness, as well as their being able to relate to the school and feeling like they belong (Fredricks; Filsecker; Lawson, 2016).

3 - Cognitive engagement: refers to students' internal cognitions, such as their willingness to dedicate themselves to learning, seeking to master new and complex ideas and competencies (Fredricks et al., 2011; Fredricks, Blumenfeld; Paris, 2004).

Other researchers separate social engagement from emotional engagement, being students' social engagement correspondent to the feeling of belonging and relating to the school (Pekrun et al., 2014; Pekrun; Linnenbrink-Garcia, 2012).

Considering the impact of gamification on students' engagement, it is believed that behavioral engagement (in the educational context — engagement in activity) is the most affected, considering that gamification makes school environments and activities more attractive. However, the concept of engagement is malleable and multifaceted, allowing interventions in one of the dimensions (behavioral) to reflect on the other dimensions (emotional and cognitive).

According to digital solutions experts, engagement is described as the quality of the user's multi-layered experience when interacting with a digital system (Donnerman et al., 2021; O'Brien; Toms, 2008). According to Donnerman et al. (2021), engagement involves the level of involvement and workload, which are directly related to the resulting learning potential. Therefore, engagement in the task/activity, that is, behavioral engagement, is the construct that is the most impacted by the insertion of gamification in a learning environment, and/or the most easily evaluated.

When activity engagement is mentioned, interest is one of the variables that increase the number of decisions to engage and stay engaged in classroom activities. Situational interest refers to activated interest since it is triggered by specific characteristics of the situation (Hidi, 1990; Hidi; Renninger, 2006; Krapp, 2005; Ainley, 2012). Research on reading regarding children, and replicated in High school, it was identified that texts with themes that meet the interests of high school students generate greater engagement in reading activity. In this case, situational interest occurred when the activity triggered arousal, attention, and positive affect. It was found that situational interest is triggered when students perceive the presence of some specific characteristics in the task, which are:

1 - Opportunity for exploration and challenge;

2 - Opportunity to have fun (Chen; Ennis, 2004; Sun et al., 2008).

At this point, gamification is linked to its insertion in the academic environment. Inserting gamification into classroom activities, when there is little or no interest in the content, causes students to engage in the activity due to triggers that are inherent to the characteristic of the gamified activity itself, considering that effective gamification is characterized by the insertion of game elements, such as missions, challenges, rewards, scores, and levels, in the activities. Consequently, gamified activities carry both characteristics of activities that trigger the situational interest responsible for engagement in the activity, described in the previous paragraph.

Conceptualized as the use of games or some game elements, gamification aims at aspects beyond entertainment. The objectives of gamified environments may be: increasing engagement in a task, increasing learning, increasing sales; that is, modifying specific behaviors in participants. In the case of students, the use of gamification aims to increase students' interest in academic activities and, consequently, increase learning (Legaki et al., 2020).

Recent studies indicate that challenge-based gamification (points, levels, leaderboards, clear objectives/tasks) positively interferes with student learning when compared to traditional teaching methods (Legaki et al., 2020). It is also important to mention that challenge-

based gamification is suggested and applied in education as opposed to gamification based on immersion and socialization (Dicheva et al., 2015; Souza Borges et al., 2014). Gamification, serious games, and game-based learning differ from games that were created for the sole purpose of entertainment. Although they are also fun, they are developed with a primary purpose that is different from entertainment and leisure. Gamification consists of a method for designing systems, services, organizations, and activities, through which experiences and motivations similar to those experienced when people play games can be created. In the case of the use of gamification in educational contexts, the primary objective is to influence students' behavior for the fulfillment of educational goals (Huotari; Hamari, 2017).

Games are known to motivate and engage players (Dichev; Dicheva, 2017). There are games that last hours, days or weeks. This psychological state of deep concentration generated by games is explained in the Flow Theory as being the integration of what is done with satisfaction, a state of mind characterized by a focused concentration and a high pleasure and interest in the execution of the activity (Csikszentmihalyi, 1990; Shernoff et al., 2003). In this sense, gamification aims to create this experience in different contexts, through the use of game mechanics or game design elements in the desired environment (Legaki et al., 2020), leading to emotional experiences that affect human motivation (Mullins; Sabherwal, 2020). The understanding that pleasure may come from a variety of positive emotions (excitement, surprise, and triumph over adverse situations) leads to the conclusion that the gamified activity must focus on providing such. Although mixed emotions (disappointment and sadness for losing the game) are inevitable during the game, they must not surpass the positive ones in order to achieve engagement in the activity. Other studies emphasize that some gamified systems applied to education have not increased or improved academic performance, highlighting the importance of using gamification design adapted to the needs of the target audience (Toda; Silva; Isotani, 2017; Oliveira et al., 2023), after all, the goal is to arouse interest in the task. For this reason, a serious game (gamified system) was built especially for this research.

This research was conducted with adolescents between 15 to 18 years of age, high school students, in Brazil. This life stage is marked by a series of complexities and diverse interests, in which the school, in its traditional and content-centered format, often occupies a secondary position in relation to the numerous experiences and discoveries presented before adolescents. In this context, reflecting about and investigating alternatives that promote increased motivation or, at least, generate an opportunity for manifestation of interest, have become essential for the people involved in the educational process: students, teachers, families, and the school community as a whole.

Adolescence corresponds to the second decade of human life, according to the World Health Organization (Organização Mundial da Saúde, 2024). Its initial milestone is biological; it occurs when the child's body begins to change, which is the sign of puberty. In girls, the first physical sign of puberty is the appearance of breast buds around the age of 10, but that may happen before adolescence, starting at the age of 8. In boys, the first sign of puberty is the enlargement of the testicles between the ages of 9 and 14. Various physical changes happen throughout puberty:

- Females: breast development with an enlarged areola integrated into the breast contour, widening of the hips, growth of pubic and axillary hair, a growth spurt, enlargement of the uterus and vagina (labia and clitoris), and, finally, menarche;
- Males: growth of pubic and axillary hair, enlargement of the penis, deepening of the voice, a growth spurt, widening of the arms and chest, and the first ejaculation (Sociedade Brasileira de Pediatria, 2024). These changes are promoted by hormones: estradiol, luteinizing hormone, follicle-stimulating hormone, testosterone.

Considering this biological and global milestone, namely the visible physical changes associated with puberty, adolescence has a well defined initial marker, whereas its termination involves less clear social factors. It is generally assumed that by the end of adolescence the young adult will have acquired sufficient autonomy to manage his or her own life, as autonomy as autonomy develops continuously and may be divided into emotional, cognitive, behavioral, and financial autonomy. Some authors point out that by the end of adolescence, a certain

behavioral autonomy will have been developed. Behavioral autonomy is understood as the conscious ability to make decisions toward an end, according to the Self-determination Theory (Deci; Ryan, 2000; Barbosa; Wagner, 2013).

The autonomy framework has different definitions and involves the expectation that adolescents, at the end of this phase, perform roles that are socially accepted in the culture in which they are inserted. This performance of social roles is expected by adolescents themselves, parents, school, and society as a whole. In this regard, adolescence, in and of itself, constitutes a period marked by physical, identity-related, behavioral, and social transformations (Barbosa; Wagner, 2013).

Still thinking about the biological development of adolescents, the adolescent brain undergoes relevant structural and functional changes that directly impact their behavior, their social and academic life and, especially, activities that require decision-making. There are research results consistent with MRI and functional neuroimaging that indicate an increase in brain white matter and a decrease in gray matter, mainly in the prefrontal cortex and parietal cortex during adolescence (Blakemore; Choudhury, 2006; Blakemore, 2012, 2018).

During adolescence, neurons undergo development through the formation of a myelin sheath around their axons, which acts as an insulator and increases the speed of transmission of information by up to 100-fold, reaching its peak at puberty, up until about 15-16 years of age. After this apex, the brain undergoes synaptic pruning, in which the most used connections are strengthened and the rarely used connections are eliminated. After puberty, the brain, which until then had developed and reached its apex, begins to adjust to its own functioning over the course of several years, until around the age of 25. This apex of the brain, at puberty, makes it difficult for adolescents to perform in tasks that require inhibitory control, processing speed, working memory, and decision-making. These skills are developed throughout adolescence and adulthood, along with the process of synaptic pruning (Blakemore; Choudhury, 2006; Blakemore, 2012, 2018).

The prefrontal cortex continues to form during adolescence, which means that adolescence is the period of understanding and regulating social behaviors, such as making decisions based on social rules. A change in both cognition and behavior is expected at this time, considering the understanding that the social experiences of adolescents throughout this period will assist in the process of synaptic pruning, and that accumulating new social experiences may influence the development of social cognitive processes. Neuroimaging studies have revealed that during adolescence, activations in the parietal and frontal cortex favor the ability to take perspective (perception and mental simulation of how others think and feel differently from oneself), even though there is an initial difficulty in taking perspective at puberty, due to the physical changes of the adolescents and their peers (Blakemore; Choudhury, 2006; Blakemore, 2012). Nevertheless, the reorganization of the motor, visual-spatial, conceptual, and emotional system related to the new brain functioning in adolescence is positive and adaptive.

Scanned adolescent brains showed an increase in the right amygdala activity and decreased activity in the ventral striatum relative to an adult's brain functioning, which triggers mainly the ventral striatum when it comes to anticipating or postponing earning opportunities, demonstrating that adolescents are more likely to seek extreme and short-term rewards to compensate for the low recruitment of the motivational brain circuit (Bjork et al., 2004; Baird; Fugelsang; Bennett, 2005). This explains risky behaviors in adolescence with decision-making resulting in bad consequences, due to a common difficulty at this stage regarding the assessment of risks and the delayed rewards that are more advantageous in the medium and long-term than the small gains in the short-term. Therefore, immediate rewards are much in demand by the adolescent brain.

During this development phase, the brain is more prepared and empowered for mathematical logical reasoning due to a more localized parietal activation, indicating advantages for algebra activities. On the other hand, the processing of emotions undergoes changes since there is a development in the brain processing system, more specifically in the amygdala (Dolan, 2002; Phillips et al., 2003; Blakemore; Choudhury, 2006). Adolescents have particular difficulty in carrying out activities that require planning, judgment, postponement of rewards and regulation of emotions (Dias; Malloy-Diniz, 2020).

Given the complexity of adolescence, adapting the academic environment to the needs and interests of this audience may be a promising strategy to increase students' engagement. And although gamification shows significant results in increasing school performance, usually attributed to increased motivation, little is known about which cognitive, emotional, and neurological mechanisms are triggered or not by gamified activities. In this sense, this research sought to evaluate the motivation to learn of adolescent students, with the insertion of a digital game (gamification) in the school routine.

METHOD

This study is characterized as an applied, quantitative, and explanatory field research, in which the objective is to verify if gamification through a digital game positively impacts the motivation to learn of high school students.

Initially, 157 high school students from Brazilian institutions located in 3 cities (Ribeirão Preto, Sertãozinho and Batatais) of the state of São Paulo took part in the research. However, only 135 students were kept in the database, according to the exclusion criteria. The final sample used, with a total of 135 participants, corresponds to adolescents between 15 and 18 years of age, 49% female and 51% male students; 65% of them were attending the 1st year of high school, 24% were attending the 2nd year of high school, and 26% were attending the 3rd year of high school.

This sampling was not random, as it followed the criteria established by the school management, taking advantage of the students' freest moments in order to avoid jeopardizing their academic routines. It is, therefore, a convenience sample, which was divided into two groups:

- Group A - 99 students in the 1st and 3rd years of high school took part in the pre- and post-tests using the HSMLS, with a 30-day interval between the two; during the interval, they played the Neil Project game.
- Group B - 36 students in the 2nd year of high school took part in the pre- and post-tests using the HSMLS, with a 30-day interval between the two, without any intervention in this time interval (control group).

Students who missed the day of the pre- or the post-test, and/or who voluntarily gave up participating during the collection process were excluded from the study.

All criteria defined by the Research Ethics Committee — CEP: CAAE Nº 44276721.5.0000.5407 were strictly followed. The instruments were applied after permission from the school authorities and parents (for participants who were under 18 years old).

The High School Motivation to Learn Scale - HSMLS (Marchiore; Alencar, 2009) was applied before and after the serious game (Neil Project) in digital format. The HSMLS was chosen as it is a nationally designed scale, considering the sociocultural and school reality of the students targeted by the research.

The HSMLS is a reformulated version of the Elementary School Motivation Scale (Neves; Boruchovitch, 2007). The version for high school consists of 34 statements to be answered on a three-point Likert scale ("never", "sometimes", and "always") and seeks to evaluate the motivation of learning of high school students. In the study by the authors of the scale, internal consistency analyses revealed Cronbach's coefficient equal to 0.80. It is composed of two factors, each with 17 statements: the first called Intrinsic Motivation (a=0.86) and the second, Extrinsic Motivation (a=0.80).

The game developed includes questions and challenges aimed at fostering specific competencies within the area of Natural Sciences and its Technologies, the only curricular component in upper secondary education that did not show an increase in average scores between 2017 and 2018 in the Exame Nacional do Ensino Médio. - ENEM -, which is a national high school exam in Brazil. It is a mobile quiz developed as an application for mobile devices operating on the Android system.

The game design is based on four main pillars: ENEM questions presented in quiz format, the promotion of learning and studying, progression through phases with increasing levels of difficulty, and a scoring system with a ranking. The game consists of a set of multiple-choice

questions interspersed with minigames that present different types of challenges, such as guiding the avatar to a spaceship, overcoming obstacles through jumps, and formula sorting, distributed throughout the phases.

In light of definitions of game elements, the developed application incorporates seven elements: progression, feedback, chance, challenges, avatar, levels, and points. In a comparative study of gamified platforms, Souza, Ribeiro e Versuti (2025) points out that engaging gamified environments may employ, depending on their objectives, up to 17 elements, including emotions, progression, resource acquisition, evaluation (feedback), chance, challenges, rewards, victory, avatar, bosses, collections, achievements, unlockable content, badges or medals, missions, levels, and points.

In this context, the digital game developed for this research incorporates seven of these elements, namely: progression, evaluation (feedback), chance, challenges, avatar, levels (phases), and points.

After planned, developed, and tested, the game was made available for download through the Play Store application. Among the participants of the group of players (group A), 54 students played on the computers of the school laboratory (the teacher in charge adapted the computers to run applications with Android system) and the other participants played using their own cell phones and/or tablets provided by the school.

Firstly, there was a preparation for the collection in schools. Initially, the project was presented to school managers with a proposal for the application of a gamification workshop, in which the methodological procedures of the research were clarified, the Neil Project Game was presented, school managers appointed a teacher to supervise, not only the research stages, but also the students while playing the Game. The teachers and all the pedagogical team attended a Gamification Workshop, where the stages of the research, and its importance regarding gamification real effects in learning environments, were clarified. In this workshop, the pedagogical team learned about gamification by playing a board game, in order for teachers to have a gamified learning experience. Afterwards, the application of the survey took place according to the following stages:

a) Step 1: The school coordinator explained the research to the students, mentioning that participants had been carefully chosen to participate in the research and that, by participating voluntarily, they would be contributing to the development of science in the country.
b) Step 2: Application of the research initial procedure. All participants answered the HSMLS (pre-test).
c) Step 3: Participants in group A played at least once a week during the 30-day interval, for at least 15 min at a time. High school 1st graders used the computers in the school lab to play games, unlike 3rd graders, who used their own cell phones and tablets belonging to the school. The participants from group B (control) took part in conventional school activities during the 30-day interval and did not have access to the game. The students in the control group were in the 2nd year of high school.
d) Step 4: All participants answered the HSMLS again (post-test).

The analysis of the instrument data was carried out through statistical treatment, using analysis of the means of motivation to learn (ML), intrinsic motivation (IM) and extrinsic motivation (EM) (result of the scores in the HSMLS) of the groups in the pre-test compared to the post-test.

The MANOVA statistical test of paired samples was applied in order to verify the existence of significant difference in the means of ML, IM, and EM of each group, comparing the result of the HSMLS pre-test with the HSMLS post- test using the R software (version 4.3.3).

RESULTS

Initially, the MANOVA model showed a difference between the times (assumed sphericity: $F(2) = 47.618$; $P = 0.000$). However, in the interaction between the studied variables and the grouping variable (participants who played and the ones who did not play), it was not possible to find statistical significance ($P > 0.05$), indicating that both groups had similar balances between

the pre-test and the post-test, with no differences between them. This finding suggests that both groups followed a similar pattern of variation in levels of motivation to learn between the pre- and post-tests, with no significant differences between those who played and those who did not. Therefore, these results indicate that gamification had no direct effect on the motivation to learn of high school students, according to the results of the HSMLS.

The results shown in Table 1 indicated a statistically non-significant decrease in the results of the post-test in relation to the pre-test in the factors of motivation to learn (ML) and intrinsic motivation (IM). In the case of motivation to learn, the mean in the pre-test was 69.43 (SD = 5.80), while in the post-test, the mean fell to 67.51 (SD = 7.1), with low effect size (Cohen's d = 0.33). Regarding intrinsic motivation, the mean decreased from 37.62 (SD = 5.52) to 36.30 (SD = 6.04), with low effect size (Cohen's d = 0.31). No change in extrinsic motivation was found. For participants who did not play, similar results were found, with statistically significant differences ($P < 0.05$) in motivation to learn and intrinsic motivation, without significant variation between pre-test and post-test in relation to extrinsic motivation. In motivation to learn, the mean in the pre-test was 68.72 (SD = 7.94) and in the post-test it was 66.55 (SD = 7.16), with low effect size (Cohen's d = 0.24). Regarding extrinsic motivation, the mean in the pre-test was 35.77 (SD = 5.57) and in the post-test it was 33.83 (SD = 5.07), also with low effect size (Cohen's d = 0.28).

An analysis was performed comparing only the 1st and 3rd year students who played (Table 2) in order to verify whether the motivation variables presented differences between the pre-test and the post-test at different levels of Education (first and third years of High School). MANOVA analysis indicated a significant difference over time (assumed sphericity: F (2) = 17.019, $P < 0.001$). However, no significant difference was observed between the groups ($P > 0.05$), suggesting that both groups showed similar changes between pre-test and post-test, without significant distinctions between them.

In the group of first-year students, statistically significant differences ($P < 0.05$) were identified in the factors motivation to learn and intrinsic motivation. For motivation to learn, the mean was 70.10 points (SD = 5.93) in the pre-test and 68.55 (SD = 6.99) in the post-test, with low effect size (Cohen's d = 0.24). Regarding intrinsic motivation, the mean was 37.74 (SD = 5.79) in the pre-test and 36.68 (SD = 5.96) in the post-test, also with low effect size (Cohen's d = 0.23). No statistically significant differences were observed between the pre-test and the post-test in the extrinsic motivation factor. As for the control students, a statistically significant difference ($P < 0.05$) was also found in the motivation to learn and intrinsic motivation. Concerning the motivation to learn, a mean of 68.72 (SD = 7.94) was obtained in the pre-test, whereas in the post-test, a mean of 66.55 (SD =7.16) was obtained, evidencing low effect size (Cohen's d = 0.24). Concerning intrinsic motivation, the mean was 35.77 (SD = 5.77) in the pre-test and 33.83 (SD = 5.07) in the post-test, also with low effect size (Cohen's d = 0.28).

Finally, in the group of students in the third year of high school, statistically significant differences were also found ($P < 0.05$) in two factors: motivation to learn and intrinsic

Table 1. Descriptive statistics of pre-test and post-test scores between groups.

		Group that played		Control group	
		Mean	**SD**	**Mean**	**SD**
ML	pre-test	69.43	5.80	68.72	7.94
ML	post-test	67.51	7.10	66.55	7.16
IM	pre-test	37.62	5.52	35.77	5.57
IM	post-test	36.30	6.04	33.83	5.07
EM	pre-test	31.73	5.07	32.88	6.00
EM	post-test	31.12	5.37	32.63	5.37

SD = standard deviation; ML = motivation to learn; IM = intrinsic motivation; EM = extrinsic motivation.
Source: Author's own elaboration.

motivation. Concerning motivation to learn, the mean was 67.09 points (SD = 4.71) in the pre-test and 63.86 points (SD = 6.25) in the post-test, with low effect size (Cohen's d = 0.25). Regarding intrinsic motivation, the mean was 37.22 points (SD = 4.71) in the pre-test and 34.95 points (SD = 6.25) in the post-test, also with low effect size (Cohen's d = 0.21).

DISCUSSION

The findings in Table 1 suggest that the experience of playing did not significantly influence the trajectory of motivation to learn compared to the control group. The decrease in motivation to learn and intrinsic motivation may be attributed to uncontrollable external factors in the study. The stability of extrinsic motivation, in turn, may indicate that the extrinsic elicitors of motivation were operating stably in these students' daily lives.

The results in Table 2 suggest that, regardless of school level, the students who took part in the intervention showed a slight decrease in the levels of motivation to learn and intrinsic motivation over time. This reduction was also observed in the control group, reinforcing the hypothesis that the variation in motivation may be related to factors external to the game, such as the educational context, the time elapsed between collections or the participants' own school routine. In addition, the stability of extrinsic motivation scores corroborates in part with neuroscience findings, which state that the adolescent brain seeks more extreme and short-term rewards to compensate for the low recruitment of the motivational brain circuit (Bjork et al., 2004; Baird; Fugelsang; Bennett, 2005; Blakemore; Choudhury, 2006; Blakemore, 2012). This may mean that, although adolescence is a period of cognitive, social and emotional development, the growth of brain connections in the prefrontal cortex (crucial for decision-making and emotional control) and in the amygdala (central for emotional processing) contribute to the intensity and volatility of emotions (Yilmazer, 2024), and, since emotional relevance is a decisive factor for decision-making and consequently for motivation, adolescents experience difficulty in staying motivated by school activities, or by medium and long-term goals.

On the other hand, precisely in adolescence, adolescents begin to replace the simple techniques of regulating emotions learned in childhood with more subtle and complex approaches that involve greater awareness and cognitive processing (Simic et al., 2021). The adolescent brain apparatus is actually ready for this cognitive, social, and emotional sophistication, enabling their self-regulation at various levels, valuing more the extrinsic elicitors of their motivation, than the intrinsic elicitors, in this case, the latter are not significant, or consist of medium and long-term reward systems, being, therefore, uninteresting. In conclusion, creating more attractive school environments, with activities that generate short-term rewards, such as the scoring system and rewards of gamified environments, may help adolescents stay interested, strengthening the extrinsic elicitors necessary for motivation and engagement in academic activities.

Table 2. Descriptive statistics of the pre-test and post-test scores of the different high school levels.

		First year		Control group		Third year	
		Mean	SD	Mean	SD	Mean	SD
ML	pre-test	70.10	5.93	68.72	7.94	67.09	4.71
ML	post-test	68.55	6.99	66.55	7.16	63.86	6.34
IM	pre-test	37.74	5.79	35.77	5.57	37.22	4.52
IM	post-test	36.68	5.96	33.83	5.07	34.95	6,25
EM	pre-test	32.27	5.25	32.88	6.00	29.86	3.89
EM	post-test	31.71	5.76	32.63	5.37	29.04	2.93

SD = standard deviation; ML = motivation to learn; IM = intrinsic motivation; EM = extrinsic motivation.
Source: Author's own elaboration.

It can be suggested that gamification in this experiment had a positive effect on engagement with activities in the school environment, considering that the volunteer adolescent students in this study did not give up gamified activities. On the contrary, they played voluntarily until the end of the study, corroborating with experts in digital solutions, who argue that engagement involves the level of engagement and workload, both of which are directly related to the resulting learning potential (Donnerman et al., 2021; O'Brien; Toms, 2008).

Finally, the absence of significant differences between the groups from different grades suggests that the effect of the game on motivation is similar among students of the 1st and 3rd grades of high school. These results may indicate that the gameplay experience did not significantly affect participants' motivation to learn, even across the different years of high school. It is important to mention that research in recent years has shown positive results in academic performance when using the gamification of educational environments (Oliveira et al., 2023); in this case, the commonly used explanation is that gamification generates increased motivation and consequently improved academic performance. According to the results, it can be inferred that motivation triggered by gamification is not the motivation to learn, but the engagement in the activity (task). Therefore, gamification in the school context may be suggested, as it is an opportunity for adolescent students to present their interests in the proposed activity.

In other words, motivation to learn is driven by mechanisms that go beyond the characteristics of activities, including gamification. However, gamification plays a key role in situational engagement in the activity, as it provides a challenging and thought-provoking environment, arousing the momentary interest of students. The main advantage of the gamification of academic activities is the promotion of the situational interest trigger. This interest represents the first contact with the content, possibly sustaining engagement in learning. In addition, under certain circumstances, this initial interest may develop into a more lasting motivation. This aspect becomes even more relevant in the current scenario, in which the massive presence of social networks and the constant exposure to digital stimuli make traditional approaches less attractive to students, reinforcing the need for innovative strategies that favor engagement and learning.

CONCLUSION

This study investigated the effects of gamification on the motivation to learn of High School students, comparing the groups that played games to the control group. The analysis of the results revealed that, although there was a slight decrease in the levels of motivation to learn and intrinsic motivation over time, there were no significant differences between the students who took part in the gamified intervention and those who did not. These findings suggest that gamification, in the context of this study, did not have a substantial direct impact on students' motivation to learn.

The results of this study diverge from the scientific literature that attributes gamification to a direct positive impact on motivation to learn in school settings. However, they converge with theoretical approaches that characterize gamification as a situational behavioral engagement factor, that is, a strategy that, by itself, does not boost motivation, but that, when well applied, may act as a trigger for motivation activation.

The findings indicate that gamification favors the involvement of students in school activities, since participants in this study remained engaged in gamified tasks, even though there was no significant increase in motivation to learn, as measured by the HSMLS. This suggests that gamification can be a valuable tool for promoting active student participation, creating opportunities for initial engagement that, under certain conditions, may evolve into a deeper interest in learning.

Future investigations may replicate this method, exploring different approaches to gamification, both in digital and face-to-face contexts. In addition, the inclusion of specific instruments to measure students' interest and level of engagement in gamified and non-gamified activities may contribute to a deeper understanding of this phenomenon. It is also necessary to analyze the characteristics of school contexts and situations that arouse positive emotions in

adolescents, allowing the development of more precise strategies to strengthen behavioral engagement and enhance its impact on learning.

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MDR: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Writing – original draft, Writing – review and editing. FMV: Conceptualization, Supervision, Writing – review and editing.

Editor: Prof. Dr. José Luís Bizelli

Deputy Executive Editor: Profa. Dra. Flavia Maria Uehara