

A systematic and comparative analysis of the impacts of Blended Learning in public schools: integration of gamification tools in team-based taxonomy

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Abstract. *This paper develops a new taxonomy for Blended Learning, aiming to enhance student autonomy through technology, active methodologies, and gamification. Utilizing a systematic literature review, an agglomerative clustering approach categorizes the taxonomy into five classes. Conceptual frameworks were then developed for each taxonomy class. The study compared Team-based Blended Learning to traditional face-to-face teaching on student learning performance. Initial observations favored the hybrid group, but statistical analysis found no significant difference, supporting the null hypothesis. These findings underscore the need for educators to embrace innovative pedagogical approaches like Blended Learning for integrating technology into public schools.*

Resumo. *Este artigo desenvolve uma nova taxonomia para Blended Learning, visando aumentar a autonomia dos alunos por meio de tecnologia, metodologias ativas e gamificação. Utilizando uma revisão sistemática da literatura, uma abordagem de agrupamento categoriza a taxonomia em cinco classes. Estruturas conceituais foram então desenvolvidas para cada classe de taxonomia. O estudo comparou o ensino híbrido baseado em equipe com o ensino presencial tradicional sobre o desempenho de aprendizagem dos alunos. As observações iniciais favoreceram o grupo híbrido, mas a análise estatística não encontrou diferença significativa, apoiando a hipótese nula. Estas descobertas sublinham a necessidade dos educadores adotarem abordagens pedagógicas inovadoras, como o ensino híbrido, para integrar a tecnologia nas escolas públicas.*

1. Introduction

Blended Learning (BL) emerged as a prominent educational approach and became even stronger during the coronavirus disease (COVID-19) pandemic, when the need for social distancing drove the search for alternative solutions for continuing education [Moreira and Lima 2023a, Lima and Isotani 2022]. Although it has recently gained prominence, BL had already been widely explored in studies prior to the pandemic, and was even recognized as a form of active methodology by some researchers [Bacich et al. 2015, Moran 2015, Valente 2015]. In turn, gamification [Ferreira et al. 2023, Sendacz et al. 2022, Lima et al. 2017, Soares et al. 2021] also stood out as a promising pedagogical practice, offering new possibilities for student engagement in the learning process.

The BL combines elements of face-to-face teaching and online teaching, allowing students to participate in activities both inside and outside the classroom. Gamification is the use of game elements and mechanics in non-game contexts to engage and motivate people to achieve specific goals [Moreira and Lima 2023b]. It transforms everyday activities into more playful and immersive experiences, promoting greater user involvement and participation [Moreira and Lima 2023c]. Finally, the active methodology involves teaching strategies that encourage the active participation of students, promoting the construction of knowledge through practical, collaborative and reflective activities. Therefore, these three approaches have in common the objective of making learning more dynamic, engaging and student-centered [Moreira and Lima 2024b].

Despite the recognition of its potential advantages, BL is the subject of debates and controversies in the academic community. While some researchers see significant opportunities to improve teaching and learning [Lima and Isotani 2022, Sendacz et al. 2022], others point out challenges for implementation and about its effectiveness compared to traditional teaching [Moreira and Lima 2024a]. To assess these divergences and knowledge gaps, we carried out a SLR, examining more than 2200 studies published between 2013 and 2022 that address BL in schools and in the teaching-learning process.

Our analysis of studies identified by the SLR revealed a wide variety of definitions and approaches to BL, highlighting the pressing need for a clear and comprehensive conceptual framework to guide its effective implementation. Based on this finding, we developed a taxonomy composed of five BL classes, using a bottom-up grouping process to categorize different modalities and approaches. Entitled Taxonomy for Blended Learning: an approach to meaningful student autonomy, our categories include: (i) Integrated Blended Learning; (ii) Connected Blended Learning; (iii) Intraschool Blended Learning; (iv) Team-Based Blended Learning; and (v) Highly Tutored Blended Learning.

Furthermore, we recognize the importance of an adequate set of tools and strategies that must be adopted by educators and educational institutions to ensure the success of blended learning and student engagement. For this purpose, in our work we present a set of 5 Conceptual Frameworks, which consist of guidelines and resources selected for each BL class identified in our taxonomy. These frameworks were developed based on the distinctive characteristics of each taxonomic approach to BL, with the aim of providing an enriching and effective learning experience.

1.1. Objectives and novelty

To validate our hypothesis, we investigated the impact of team-based blended learning, augmented by gamified activities, on students' academic performance. Our **primary aim** was to determine if implementing BL could significantly enhance learning experiences, fostering deeper engagement and more enduring knowledge retention. Due to constraints, we couldn't test all five BL taxonomy classes from the dissertation. Nonetheless, we believe this approach, representing one class in our taxonomy, has potential comparability with traditional teaching, especially when combined with innovative pedagogical strategies and digital technologies. This study presents an **original approach**, combining SLR to craft a New BL Taxonomy and conceptual frameworks to guide BL implementation in public schools. An experimental study empirically evaluated this approach against traditional teaching, assessing its equivalence in public school settings. Thus, our contributions offer a comprehensive understanding of BL and provide guidelines for educators and policymakers aiming to enhance teaching and student engagement through technology both

in and out of the classroom.

1.2. Document structure

This document discusses the results obtained during the research of the Professional Master's Degree in Technological Education with Dissertation¹ titled "Explorando o ensino híbrido como tendência educacional: abordagens tecnológicas em uma escola da rede pública". The text is organized as follows: in Section 1, the Introduction of the work is presented. Next, in Section 2, some initial concepts are addressed, formalizing the theoretical foundation. The methodology and classification of the master's research are discussed in Section 3. In Section 4, the research results are presented, from the SRL to the conception of the new Taxonomy for Blended Learning, along with the experience report. Finally, the conclusions and limitations are discussed in Section 5, including suggestions for future work.

2. Theoretical foundation

Blended learning in its original definition is a teaching modality in which online and face-to-face classes complement each other, with a focus on personalized learning, making use of various digital technological resources, allowing the student to learn at their own pace and rhythm [Bacich et al. 2015]. In this teaching modality, the student is seen as the protagonist and the teacher as the mediator within this process, enabling both collective and individual activities. However, this does not mean that the teacher has to create a script for each student, but rather that they will develop different activities to meet the needs of different profiles with similar needs [Moreira and Lima 2023b].

Active methodology is a teaching approach that makes students the main actors in their own learning, engaging them in constructing knowledge. Unlike traditional methods, it involves practical, collaborative, and reflective activities, fostering significant and lasting learning. These strategies stimulate critical thinking, creativity, and problem-solving, preparing students for contemporary challenges. Gamification uses game elements in non-game contexts to engage and motivate people to achieve specific goals [Moreira and Lima 2023b]. This approach turns everyday activities into playful, immersive experiences, promoting greater user engagement. By integrating points, levels, rewards, and challenges, gamification makes tasks more attractive and stimulating.

A Conceptual Framework is a structure that organizes and synthesizes concepts, principles, and guidelines related to a particular area of study or practice. It provides a solid theoretical basis for guiding the implementation and development of strategies, methods, and resources in the BL context. By offering clear guidelines and adequate resources, a Conceptual Framework can facilitate the design and planning of learning activities, promoting effective integration between the face-to-face and online components of blended learning.

3. Methodology

The research is of an applied nature in the context of computer science in education and has a qualitative-quantitative method, which combines both data collection and analysis techniques in the same research design. The central hypothesis justifying the mixed

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approach is that the interaction between them provides better analytical possibilities [Creswell et al. 2009]. Our research adopts an exploratory and descriptive approach. Exploratory, as it seeks to understand the relationships between blended learning, active methodology, and gamification, exploring their interactions and impacts in the educational context. Additionally, the research is descriptive, aiming to detail the characteristics, processes, and results of the use of these combined approaches. As for the methods, it involves field research for data collection in educational environments and bibliographic research for the review of existing literature. Additionally, a case study will be conducted at a specific educational institution to investigate the implementation and results of blended learning with gamification and active methodology.

Figure 1 presents the 5 methodological steps adopted to achieve the research results. Initially, we defined the theme and materials to be used. As the main material used, we chose StArt to facilitate the organization of collected data. Next, we conducted a Systematic Literature Review (SLR) to develop a taxonomy that categorizes the different approaches to BL identified. Using the agglomerative clustering technique

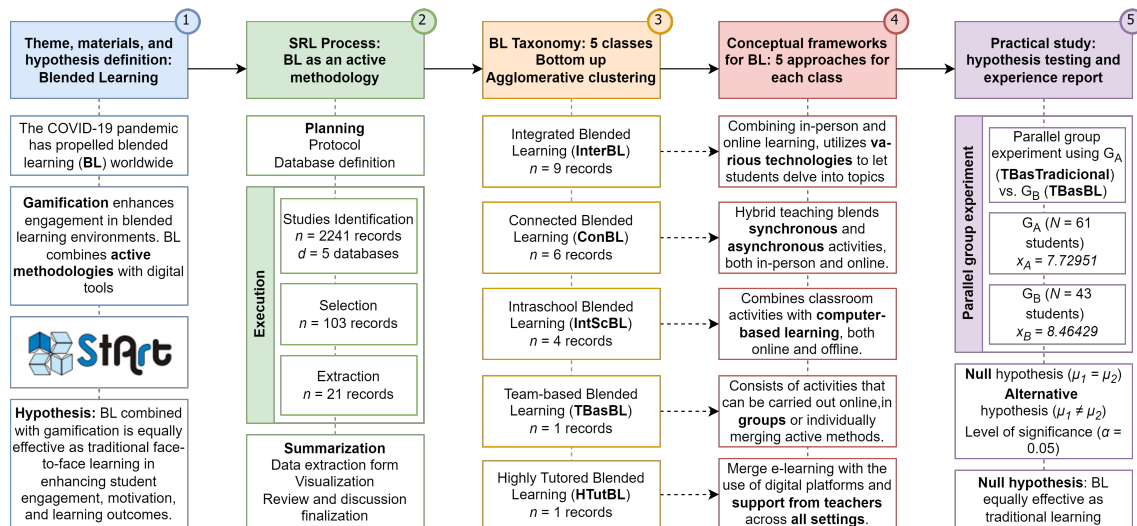


Figure 1. Taxonomy Methodology and hypothesis testing through practical study.

[Lima et al. 2021], we developed a new taxonomy for Blended Learning, called 'Blended Learning: an approach to improve and modernize education.' We then created conceptual frameworks to facilitate the implementation of BL in public schools. Next, we conducted an experimental study with lesson plans for hybrid and traditional approaches in elementary education, including population definitions, materials, syllabus, and assessment tools. We reported on four weeks of student activities and provided insights into the hybrid approach. A self-assessment questionnaire using a Likert scale measured attitudes, opinions, beliefs, and behaviors. Qualitative and quantitative analyses of the evaluations were conducted using Likert-type comparative descriptive analysis and hypothesis testing. We conclude that this process can be replicated by other teachers interested in adopting hybrid approaches in the school context.

4. Results and discussion

In this section, we will briefly present the results obtained in the master's thesis. Initially, we will discuss the definition of theme, material and hypotheses. Next, we will address the

methodology for SRL, exploring work on BL from the last decade, followed by the presentation of the new taxonomy derived from SRL and the conceptual framework. Finally, we will describe the experimental application of the new taxonomy category, involving 103 students, as reported in the parallel experimental study.

4.1. Theme, material, and hypothesis definition

The BL has emerged as a prominent educational approach, especially accelerated by the COVID-19 pandemic, necessitating alternative teaching methods worldwide. BL integrates active methodologies with digital tools, providing a BL experience that combines face-to-face interactions with online resources. Additionally, gamification has been recognized for its ability to enhance engagement within BL environments by incorporating game elements into educational activities. Our hypothesis suggests that blending BL with gamification can yield outcomes comparable to traditional face-to-face learning in terms of enhancing student engagement, motivation, and overall learning outcomes.

4.2. Systematic Literature Review

A Systematic Literature Review (SLR) aims to identify, evaluate and summarize evidence from existing studies on a specific topic, using predefined criteria for selection and analysis [Kitchenham et al. 2009, Lima and Isotani 2022]. The aim is to provide a comprehensive overview of current knowledge in a given area, highlighting gaps, trends and future research directions. In our study, we conducted an SRL to deepen understanding of BL definitions and to answer our hypothesis, we formulated three research questions (RQ) to guide our investigation:

- RQ1** Can the use of Blended Learning in public elementary schools contribute to engaged learning on the part of students?
- RQ2** Can the use of Blended Learning in public elementary schools contribute to autonomous learning for students?
- RQ3** What evidence can be found that using Blended Learning in the classroom promotes meaningful learning?

We carried out an SLR with articles from the last decade in the period from 2013 to 2022. To facilitate the synthesis of the data found, we used the State of Art² (StArt) Tool [Fabbri et al. 2012, Hernandez et al. 2012]. The articles selected for this Systematic Literature Review were collected on several research platforms, including Scopus, IEEE, Web of Science, Scielo and Engineering Village. These platforms were chosen due to their reputation for publishing high-quality scientific articles in various areas of knowledge. The SRL process was conducted following the steps outlined in Figure 1, resulting in the identification and initial analysis of 2241 articles, which underwent an initial analysis. After this stage, we moved on to the selection of articles, refining the screening through the analysis of titles, keywords and abstracts, resulting in the selection of 103 articles. We then carried out a complete reading of these 103 articles, of which 80 were excluded based on the exclusion criteria, 2 were identified as duplicates and 21 were considered relevant and included in the analysis. With the 21 articles accepted, we summarized them and, in this process, identified five distinct hybrid modalities. Based

²StArt (State of the Art through Systematic Review) application developed by the Federal University of São Carlos (UFSCAR). Access link: http://lapes.dc.ufscar.br/tools/start_tool.

on this information, we systematized and grouped the articles into five categories.

In **first group** (Gr_1), research by [Yang and Ogata 2023, Phelps and Moro 2022, Chen 2022, Wong 2022, Chua and Islam 2021, Ahlin 2020, Saritepeci and Çakır 2015, Etom et al. 2021, Darmawan et al. 2021] bring in their studies the idea of BL as the combination of communication face-to-face and online, incorporating different technological resources into the structure of classes, allowing students to explore topics and share experiences in person and online. In **second group** (Gr_2), research by [Argyriou et al. 2022, Avramenko et al. 2021, Sudirta et al. 2022, Abdul Rahim et al. 2022, Ahmed et al. 2022] Blended Learning is a combination of synchronous and asynchronous activities, which occur via virtual learning platforms, through the use of technological equipment such as Smartphones, Tablets, Computers and others, in addition to internet access. Synchronous moments are similar to physical classrooms in terms of the presence of the teacher during the presentation of the content to be worked on in class, where the teacher is the mediator, providing support, answering questions and helping students during classes. Asynchronous moments include activities available through digital platforms such as Moodle and Google Classroom.

In **third group** (Gr_3) in the studies of [de Brito Lima et al. 2022, Kundu et al. 2021, Indriyanti et al. 2020], their research brings Blended Learning as the combination of classroom activities with activities carried out through the use of different technological resources, such as computers and tablets, both online and offline, within the school environment. In **fourth group** (Gr_4), in the work of [Shen et al. 2022], it brings a different way of applying BL. In this model, as in others, students have access to part of the content that is carried out online, allowing them to complete it at their preferred time, pace and location. The difference in this modality is that the activities are carried out in teams. And finally, in **fifth group** (Gr_5), the [Cui et al. 2022] study addresses BL, which combines face-to-face classes with the use of digital platforms and support from teachers in all environments. The difference between this approach is intrinsically related to the fact that, in activities conducted in the virtual environment, students have the opportunity to count on the valuable assistance and guidance provided by their teachers.

Among the SRL results, it was noticed that the combination of face-to-face and online teaching [Etom et al. 2021] presents a significant improvement in students' ability to develop interest in learning [Shen et al. 2022], with a better performance of scientific reasoning and in solving problems [Syafil et al. 2021], in addition to increasing the autonomy and independence of students [Abdul Rahim et al. 2022].

4.3. New Taxonomy for Blended Learning

After the reflections carried out in SRL, as evidenced in step 3 (in yellow) of Figure 1 of Section 3, it was observed that among the 21 works there were different conceptions of BL, the which led to the decision to separate these ideas and group them for a better visualization of the concepts. In this sense, a Taxonomy was created to elucidate these concepts. To arrive at these concepts, we began by dividing the 21 articles into five categories, which included (a) authors, (b) concepts, (c) materials, (d) methods, and (e) definitions, using a bottom-up approach. Initially, each of the 21 works was placed in its own cluster, and then we sought to combine the clusters in pairs until forming a coherent number of clusters that represented the classes for the BL. To do this, we identified the concepts presented by each of the 21 authors, then we examined the materials and meth-

ods used for a better understanding, and finally, after a thorough analysis, we created a definition for each grouping, resulting in five categories, which represent our taxonomy.

Our new “Approaches for Blended Learning” taxonomy, published in [Moreira and Lima 2024b], is divided into five main categories, each representing a specific approach to blended learning: $[Gr_1]$: “Integrated Blended Learning” (InterBL), $[Gr_2]$: “Connected Blended Learning” (ConBL), $[Gr_3]$: “Intraschool Blended Learning” (IntScBL), $[Gr_4]$: “Team-based Blended Learning” (TBasBL) and $[Gr_5]$: “Highly Tutored Blended Learning” (HTutBL).

Each of these blended learning approaches offers a variety of opportunities to combine in-person and virtual interactions, creating more personalized, flexible, and effective educational strategies. **InterBL** combines the traditional classroom with online activities, allowing flexible access to content anytime, anywhere, with in-person and virtual interactions. During the COVID-19 pandemic, **ConBL** gained prominence, involving synchronous moments with teachers and asynchronous activities on digital platforms. **IntScBL** combines face-to-face and online activities within the school environment, maximizing the learning experience. **TBasBL** encourages collaborative skills and responsibility, while **HTutBL** highlights the essential role of the teacher in physical and digital environments, offering an enriching experience and constant support to students.

4.4. Conceptual Framework

The term framework can be understood as a set of pre-defined techniques, tools or concepts used to solve a problem, that is, it is a working structure that employs pre-established functions adaptable to different situations [Hult et al. 2011]. The purpose of this framework is to make research results more rigorous and meaningful, enable theory development, and ensure generalizability.

Due to the page limit of this article, it is not possible to include images of the five Conceptual Frameworks (CF) created from the Taxonomy created based on RSL, as shown in Step 3 (in red) of Figure 1 in Section 3. Therefore, a summary about the central elements of the frameworks is presented. The CF provides an overview of key features and elements for various BL frameworks, including InterBL, ConBL, IntScBL, TBasBL, and HTutBL. Each framework emphasizes different learning objectives, technology integration, teaching modalities, instructional design, and technical support mechanisms. **InterBL** focuses on fostering autonomy, engagement, and decision-making skills among students, supported by technology platforms like Zoom, Moodle, and others. **ConBL** aims to develop autonomy, time management, and reflective thinking through synchronous and asynchronous teaching modalities using tools such as Moodle, Teams, and Zoom. **IntScBL** emphasizes autonomy, participation, and responsibility within the school environment, integrating online and offline activities. **TBasBL** promotes collaboration, integration, and autonomy through individual and group activities conducted both face-to-face and online. **HTutBL** encourages participation, reflection, and problem-solving with the support of tutors or IT teachers during in-person and online activities. These frameworks offer educators a diverse range of approaches to tailor BL implementations to meet specific learning objectives, technological capabilities, and pedagogical preferences within educational settings. However, the set of frameworks for applying BL in public schools is available in the Dissertation, in the educational product developed as an integral part of the Master’s Degree and in the article “Conceptual framework proposal based on a new taxonomy for blended learning: an approach to enhance and modernize

education”, published in [Moreira and Lima 2023a].

4.5. Report of parallel group experiment

The report involved four 9th-grade classes in the final years of a public school in the Minas Gerais State Network. The classes were divided into two groups: Group A (G_A) and Group B (G_B). Each group experienced distinct teaching methods over four weeks. G_A followed a conventional approach, conducting activities in school using traditional resources like whiteboards, handouts, lectures, and unplugged active methodologies. On the other hand, G_B adopted a hybrid approach, integrating technology and gamification. Team-based Blended Learning (TBasBL) was chosen, involving both in-person and online group tasks. This approach was selected for its blend of face-to-face and online activities, promoting flexibility and collaboration among students. Online tasks helped develop collaboration and communication skills for cooperative learning. Despite limitations, TBasBL was preferred for its hybrid nature, combining face-to-face interaction with online activities. In both groups, the first class included a slide presentation on the theme “Life Project” from the National Common Curricular Base (BNCC), aiming to encourage reflection on designing future paths based on personal and social goals.

Students in G_A created mini-posters, while those in G_B made videos about notable figures. In the third class, both groups developed games based on the “Life Project” theme. G_A students used provided materials, while G_B students created online games using technology. At the final class, students completed a Likert scale questionnaire assessing their effort, learning, and teacher skills, and graded activities over four weeks. Each group had five minutes for self-assessment before presenting their games. The analysis included a Likert-type comparative analysis and hypothesis testing, focusing on various aspects such as participation, creativity, teamwork, and overall activity evaluation.

In self-assessment, G_B showed greater effort compared to G_A . For instance, 88% of G_B students agreed they read guidelines and clarified doubts when needed, while only 56% of G_A students did so, with 25% disagreeing. In terms of learning, all G_B students declared activities contributed to acquiring new knowledge, while 13% of G_A students disagreed. Additionally, G_B students had a more positive evaluation of the required knowledge and knowledge acquired at the end of activities compared to G_A . Both groups demonstrated similar prior knowledge levels before activities.

In the final assessment, neither group considered activities weak. Besides that, G_A had one moderate and seven satisfactory ratings, while 32.3% of G_A and 12.2% of G_B rated activities as very good. Table 1 presents the final evaluation of the activities carried out by the students. Approximately 55% of G_A and 88% of G_B rated activities as excellent, indicating satisfactory performance in Team-based Blended Learning. No groups rated activities as weak, with only a small percentage classifying them as moderate or satisfactory. Additionally, G_B had a slightly higher average self-assessment score (4.881) compared to G_A (4.4098), suggesting a more positive perception of activities among G_B students. This implies that team-based blended learning with gamified activities may have enhanced the learning experience for students, as reflected in their final assessments.

Continuing the analysis, we aimed to investigate whether the use of Blended Learning in public elementary schools could lead to efficient learning for students. The hypothesis proposed was that students undergoing Team-based Blended Learning with gamified activities would demonstrate academic performance comparable to conventional teaching, with minimal or no use of digital technologies. To test this hypothesis, we con-

Table 1. Comparison of self-assessment and teacher-student activity evaluation.

QUESTION	Group A 61 students	Group B 42 students	Total (N = 103)
SELF-ASSESSMENT	What is your self-assessment at the end of the activities carried out?		
Weak	0 (0%)	0 (0%)	0 (0%)
Moderate	1 (1.6%)	0 (0%)	1 (1.0%)
Satisfactory	7 (11.5%)	0 (0%)	7 (6.8%)
Very Good	19 (31.1%)	5 (12.2%)	25 (24.3%)
Excellent	34 (55.7%)	37 (88.1%)	71 (68.9%)
GROUP SIZE	Percentages and averages of self-assessment for each group of students.		
Group A 61 students	61 (100%)	0 (0%)	61 (60.2%)
Group B 42 students	0 (0%)	42 (100%)	42 (39.8%)
Self-assessment averages	4.4098	4.881	4.6019
TEACHER	What is the grade given by the teacher at the end of the activities carried out?		
Creativity	1.43442	1.62904	2.0
Theoretical basis	1.54508	1.73214	2.0
Game difficulty level	1.46311	1.57738	2.0
Clarity in the objective of the game	1.47540	1.60714	2.0
Participation	1.00000	1.00000	1.0
Teamwork	0.78196	0.90476	1.0
Total	10.0	10.0	10.0
Group Mean	7.72951	8.46429	8.0969
Standard deviation	1.7214	0.6662	1.1938
p-value	0.8917	t-Student	0.1385

ducted a t-Student Test³, a commonly used statistical test, to determine whether there is a significant difference between the means of two groups. The null hypothesis (H_0) posited that there is no significant difference in student performance between the group receiving Blended Learning with gamification and the group receiving traditional face-to-face teaching without gamified elements. Conversely, the alternative hypothesis (H_1) suggested that the performance of students in the group receiving Blended Learning with gamification is significantly higher than that of the group receiving traditional face-to-face teaching without gamified elements.

In this context, the null hypothesis (H_0) assumes that any difference observed in student performance is due to chance, not being influenced by the introduction of Blended Learning or gamification, that is, that BL is comparable to traditional teaching. The alternative hypothesis (H_1), on the other hand, suggests that the introduction of blended learning, especially with gamification elements, will result in a significant difference in student performance compared to traditional face-to-face teaching. For this analysis, some criteria and their respective weights were used, as it is possible to see in Table 1 the representativeness of the academic performance evaluation criteria, together with the averages obtained by the groups G_A and G_B .

When analyzing the arithmetic average of the grades achieved by students in both groups, it can be seen that G_B had a higher average compared to G_A . What could initially lead to the assumption that G_B received a more efficient method for learning than G_A . Let's now look at the results obtained from *t-student's* statistical calculation. The analysis of the significance level shows that the difference between the two means is not statistically significant, therefore, the null hypothesis must be maintained. In this sense, it is possible to conclude that there are no relevant differences between the two averages, as can be seen in Table 1.

³Stats.Blue application, Two-Sample t-Test Calculator https://stats.blue/Stats_Suite.

The hypothesis test was conducted to compare the learning effect of blended learning (BL) with gamification elements to traditional teaching methods. The null hypothesis (H_0) stated that there is no difference in the learning effect between the two teaching approaches, while the alternative hypothesis (H_1) posited that BL with gamification elements has a different learning effect compared to traditional teaching. Using a significance level of $\alpha = 0.05$, the sample data from groups G_A ($\bar{x}_{G_A} = 7.7295$) and G_B ($\bar{x}_{G_B} = 8.4643$) were analyzed. The calculated t-statistic was -3.0214 , and the p-value was found to be 0.0 . With a critical t-value of 0 and a confidence interval spanning from -0.7348 to -0.7348 , it was concluded that there is insufficient evidence to reject the null hypothesis. Therefore, the results suggest that BL with gamification elements does not have a significantly different learning effect compared to traditional teaching. It means that blended learning, when implemented correctly, can produce results comparable to traditional teaching on certain academic performance metrics.

This emphasizes the need for flexible education, where varied teaching methods are combined to meet students' needs. Educators must embrace new approaches like blended learning, understanding how to apply them effectively. This fosters enriching educational experiences, particularly through technology, vital for students today.

5. Conclusions

Based on the SLR, Blended Learning aims to enhance student autonomy through increased flexibility. Flexible activities enable students to access materials as needed, regardless of their location [Moreira et al. 2023]. In this model, students manage their study time and engage in both in-person and synchronous classes. From the SLR, 10 teacher recommendations were derived [Moreira and Lima 2024b]. Using the bottom-up methodology, RSL studies were categorized into 5 groups representing the Blended Learning taxonomy of the past decade. These categories led to the development of 5 conceptual frameworks for implementing Blended Learning in public schools, tailored to each school's context.

In the practical study, the null hypothesis was tested, indicating no significant difference in student learning performance and interest between the Team-based BL (TBasBL) approach and traditional teaching. Although G_B average initially outperformed G_A , statistical analysis using the t-Student test found no significant difference, supporting the null hypothesis. Thus, Team-based Blended Learning's impact on academic performance compared to traditional teaching was similar. This underscores Team-based BL's effectiveness but doesn't negate other 4 New BL Taxonomy approaches' efficacy in varying contexts. These findings emphasize the importance of educational flexibility in blending teaching methods to meet students' needs and goals. Educators should embrace innovative pedagogical approaches, such as Blended Learning, to provide a meaningful educational experience, particularly leveraging technology.

Despite efforts to minimize biases, limitations exist. The participant sample size may have been insufficient, impacting result generalization. Time constraints may have affected data collection and methodology implementation, reducing analysis depth. The use of structured questionnaires might not fully capture student responses, but due to time constraints, employing unstructured questionnaires was not feasible, although it could be considered for future research. Additionally, due to scheduling constraints, the other four new BL Taxonomy were not examined, limiting our understanding of different approaches and their effects.

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