Research Article

Sergio Francisco Sargo Ferreira Lopes*, Jorge Manuel de Azevedo Pereira Simões, Justino Marco Ronda Lourenço, José Carlos Pereira de Morais

The Flipped Classroom Optimized Through Gamification and Team-Based Learning

https://doi.org/10.1515/edu-2022-0227
received November 03, 2022; accepted February 10, 2024

Abstract: The increase in digital teaching and learning methodologies creates the opportunity for new educational approaches, both in terms of pedagogical practice and in the availability of new technological tools. The flipped classroom as an active teaching methodology is one example of blended learning (b-learning), which aims to harmonize and enhance the fusion of face-to-face teaching with online teaching, allowing students to get better use of both face-to-face contact with classmates and professors and digital teaching resources. However, active teaching methodologies allow us to merge educational techniques from different methodological approaches, for example, gamification and team-based learning (TBL), among others. This study aims to demonstrate how to implement a flipped classroom with the possibility of integrating gamification and TBL, indicating possibilities and challenges to overcome, through the comparative study and research carried out with students in higher education. The study was conducted with a group of 88 students from the engineering and technology fields, which showed that students have a very positive perception of active teaching methodologies and their teaching and learning techniques, especially those involving digital. Data collection was performed by a survey submitted to quantitative analysis using the Software SPSS version 28.

Keywords: flipped classroom, gamification, team-based learning, b-learning, e-learning, distance learning, field research, virtual learning environment, information and communications technology

1 Introduction

The methodology of teaching and learning is a topic of continuous reflection and debate in the academic environment, especially concerning the implementation of digital technologies, which are continuously enhanced in terms of resources and functionalities (Vrana, 2022), or by the initiative of educational institutions that implement systems developed by the institutions themselves, such as educational systems created by computer companies specialized in software development, which offer a considerable variety of systems and possibilities in terms of resources and functionalities, for academic management, management, and creation of author content and synchronous and asynchronous communication of professors and students in e-learning teaching environments (Vershitskaya, Mikhaylova, Gilmanshina, Dorozhkin, & Epaneshnikov, 2020).

During the period of the pandemic by COVID-19, teaching and learning processes were centred on digital synchronous/asynchronous communication tools and virtual learning environments (VLE), directed to the context of e-learning, given mandatory isolation.

However, if there was a quantitative and qualitative increase on the technology side, especially in virtual synchronous communication environments, in practice, we should consider that these processes are always directed to professors and students who have the most varied levels of digital literacy and adaptability to teaching models involving digital (Soares, Silva, & Moncaio, 2019).

When implementing active teaching methodologies, it is essential to observe the various aspects that are related
to the cultural and behavioural factors of students and daily teaching practice in the context of teaching and learning processes (Kaymakamoglu, 2018; Lopes, Gouveia, & da Cunha Reis, 2019).

The implementation of the “new” teaching methodologies and techniques takes place in a planned and phased manner, observing the impact on the learning process of the students and on the adaptation of the professors themselves, who may require training for the learning of new educational strategies, especially those involving digital technologies, which can enhance and optimize more efficiently the resources available, both at the pedagogical level and in purely technological terms (Cerezo, Bogarín, Esteban, & Romero, 2020).

The existence of different academic realities, specifically considering Higher Education (Sousa-Pereira & Leite, 2018), whose organization is composed of various areas of scientific knowledge, organized by other courses that contain in its structure a vast number of disciplines, we tend to consider that the implementation of a single teaching and learning methodology may not be sufficient or adequate to the needs of professors and students. Therefore, one of the possibilities is to implement teaching and learning techniques that come from different pedagogical methodologies (Soares et al., 2019) adapting the teaching models around the needs of a given subject.

The active teaching methodologies have characteristics that allow making students protagonists of their teaching and learning process, integrating digital and teamwork to optimize the acquisition of knowledge, expanded by the process of interaction between professors and students, students and students, added to the available technological resources, which can expand the capacity to acquire knowledge (Martínez Casanovas, Ruiz-Munzón, & Buil-Fabregá, 2022).

Techniques allow promoting a more targeted use of digital resources in environments and e/b-learning to increase the effectiveness of students’ learning through more effective interactivity involving various techniques from, e.g., flipped classroom (FC), gamification, and team-based learning (TBL), which are the methodological proposals targeted by this work, considered among themselves, as potential potentiators of their teaching and learning techniques and processes.

However, it is demonstrated in the scientific literature (Mercat, 2022) that many active methodologies enhance different aspects of the process of acquiring knowledge, making it possible to work in different contexts through teaching techniques that are more appropriate to the specificities of different educational contents, according to the need of the scientific knowledge areas.

1.1 The Flipped Classroom as a Means of Merging Active Teaching Methodologies

The FC is an active teaching and learning methodology, within the scope of b-learning, which has in all its techniques, a series of procedures that were implemented gradually and empirically over time (Moran & Milsom, 2015) from 1990, through the implementation of specific and dispersed practices, which even at the time had other names such as inverted classroom.

Therefore, in this period, there was not exactly a defined model of FC, but a set of active teaching techniques involving digital and classroom and distance teaching that aimed in some way to optimize students’ learning, not only in the presence of the professor in the classroom but also at the time of homework and individual study of students.

However, from the year 2006, Bergmann and Sams (2012), two professors of K12 in the United States, began the process of implementation of FC, consolidating the active techniques of inverted classroom with digital, forming a new active methodology under the name of FC that eventually gained relevance in the academic environment, resulting in a reference book, which we present in Table 1, an example of the applicability of FC compared to the traditional classroom model of teaching.

When analysing Table 1, we can verify a significant change in the dynamics of the classes, the most notorious

<table>
<thead>
<tr>
<th>Table 1: Traditional classroom versus flipped classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activity</strong></td>
</tr>
<tr>
<td>Warm-up activity</td>
</tr>
<tr>
<td>Go over previous night’s homework</td>
</tr>
<tr>
<td>Lecture new content</td>
</tr>
<tr>
<td>Guided and independent practice and/or lab activity</td>
</tr>
</tbody>
</table>

Source: (Bergmann & Sams, 2012, p. 15).
of which in the F2F class is the elimination of the presentation of the contents of the subject by the professor who begins to concentrate F2F classes on practical and/or laboratory activities that direct learning in the sense of knowing-how. In this context, the presentation of the content is directed to the asynchronous e-learning study, in which the student studies the contents of the subject, performs previous activities, and assists in his home or elsewhere that has a computer with Internet access, to the videos recorded and made available by the professor in VLE, before the meeting in F2F class (Bergmann & Sams, 2012; Bergmann, Overmyer, & Wilie, 2013; Lopes et al., 2019).

The implementation of FC will require students to increase their role in the teaching and learning process because the effectiveness in implementing the methodology will depend on the initiative of the students to study and is prepared in advance for the F2F class that will take place later, at risk of invalidating the application of FC by the professor, if the students are not mature enough to realize the importance of preparation in the e-learning study (Singh, Jacob-John, Nagpal, & Inglis, 2021).

On the other hand, the motivation of students for e-learning studies involves not only issues related to digital literacy but also by the attractiveness of the content available in VLE, so that students feel instigated to study, and this aspect is related to professor's ability to prepare diverse contents such as videos, texts, and games (Sailer & Sailer, 2021). Within the context of e-learning, the use of techniques derived from the active gamification methodology may be a way to make the contents more interesting and appealing to students, and in this context, we can already observe the first opportunity to merge active teaching techniques of different methodologies, seeking to increase the efficiency of the teaching and learning process.

Morais et al. (2021b) conducted a case study with students, which demonstrated that the use of educational games promotes a greater interest of students in studying the contents of the subject, in addition to making the educational process more dynamic by being connected with the use of digital tools, e.g., Kahoot!, Quizizz, Nearpod, and Socrative, that can be implemented in e-learning and F2F classes.

However, it is not enough to implement digital tools if there is no prior planning of the classes, such as a conscious division of the contents (Lopes et al., 2019), so that the level of difficulty and the guiding thread of the themes are properly balanced and strategically divided, so that in FC, students can comply with the proposed activities in e-learning regime and consequently continue in the F2F class. Therefore, this activity of responsibility of the professor will require this strategic planning and in some cases the study and learning of various digital resources, which can be a demotivating aspect for some professors with a lower degree of digital literacy.

Lopes, Gouveia, and da Cunha Reis (2020) propose a new implementation model called “MaCAIES,” which presents some guiding phases of the e-learning and F2F class preparation process that can facilitate the strategic process of dividing the contents of the subject, division of times, level of requirement in e-learning and F2F classes and types of activities, involving the problem-based learning (PBL) and TBL methodology, among other techniques, organized in four phases called: (i) preparation; (ii) pre-class e-learning; (iii) classroom class; and (iv) classroom post-class, being possible to observe in the model the proposal of use of techniques derived from various methodologies, which can be a starting point and a facilitator in the FC implementation process, with techniques departing from other active teaching and learning methodologies.

Despite the implementation of the active FC methodology in conjunction with the PBL, TBL, and gamification, boosting the involvement of students in their own teaching and learning process, challenges can occur in the implementation, and we observe a popularization of the active methodology in university education (Jung, Park, Kim, & Park, 2022; Luong, Falkenberg, & Rahimian, 2021), and many students tend to feel more comfortable with traditional classes made by lectures in which students adopt a more passive posture.

However, it is observed in experiments carried out with the implementation of FC that from the moment students assimilate the FC processes, in many cases, they come to like the methodology, reporting that they feel more prepared for evaluations because they were taking advantage of the time of the F2F classes to practice more intensely with laboratory activities and practices (Mason & Gayton, 2022).

The implementation of FC mixed with other active methodologies occurs in all scientific areas, e.g., in the health area, more specifically in psychopathology, in which Van Beek (2021) presents us with a study conducted with psychology students, who demonstrate to have obtained a better understanding of the contents and objectives intended with their learning in the classes in which the professor used FC and TBL. The students reported that the fact that there was greater interactivity with the professor and classmates increased the level of understanding and managed to have better efficiency and effectiveness in their learning process.

In the scientific literature, we can verify that the implementation of FC, either individually or in conjunction with other active methodologies, has been increasing in popularity, especially in high school and higher education (Galindo-Dominguez, 2021), demonstrating a greater engagement of
students, with increased motivation, cooperation between students, and a feeling of self-efficacy.

However, active methodologies are highly dependent on the level of maturity of students and the commitment of professors to plan and develop correctly sized content, either in quantity or in complexity, which will require a curve of professor learning, planning, and experimentation within the scientific area in which they teach, in view of the feedback of students in the performance demonstrated (Choo, Zhao, Lee, Runshe, & Krouseloff, 2021).

The FC, together with the active teaching methodologies, tends to improve the performance of students in their learning process (Lopes, Gouveia, & Reis, 2021; Torres-Martín, Acal, El-Homrani, & Mingorance-Estrada, 2022), but it is highly dependent on the level of maturity and the engagement of students and professors to achieve pedagogical objectives, requiring a learning curve and change of academic culture and practice.

1.2 The Gamification in Online Classes

Gamification is a concept known for more than 10 years that started to be around in social media and research papers in 2010 (Dicheva & Dicheva, 2017). The concept was defined by Deterding, Dixon, Khaled, and Nacke (2011) as “the use of game design elements in non-game contexts.” Game design elements like points, badges, leaderboards, rewards systems, levels, or progressive disclosure of contents can be used in contexts not related to games to get participants to achieve the same levels of engagement and motivation found in videogame players. Gamification research focused on how game features can be employed in nongame contexts to reach these goals (Chans & Castro, 2021).

Education is a main nongame context where gamification has been applied with a significant potential for further research, especially regarding its impact on learners’ motivation and enjoyment (Sailer & Homner, 2020; Trinidad, Ruiz & Calderón, 2021). Students’ engagement is considered an essential attribute to influence students’ achievement (Raju, Bhat, Bhat, D’Souza, & Singh, 2021). This importance was early highlighted by Lee and Hammer (2011) who introduced gamification as an alternative approach to game-based learning and a way to improve students’ motivation and engagement. Gamification in learning environments mainly has the support of digital platforms and tools and became a strategy used in online learning (Chans & Castro, 2021). It is also possible to find education-specific gamification platforms (Dicheva, Irwin, & Dichev, 2017).

Gamification in educational contexts is not the same as game-based learning or serious games. Game-based learning is the use, for educational purposes, of videogames, built without any pedagogical or learning objectives, and serious games are games built with a learning purpose. Whatever the context, gamification just uses elements and techniques extracted from games but not fully fledged games.

Although some authors claim for more empirical research (Dicheva & Dicheva, 2017; Dicheva, Dichev, Agre, & Angelova, 2015; Khalil, Wong, de Koning, Ehner, & Paas, 2018; Manzano-León et al., 2021) and for improved methodological rigor (Rapp, Hopfgartner, Hamari, Linehan, & Cena, 2019; Sailer & Homner, 2020; Sailer & Sailer, 2021), positive results concerning students’ motivation and engagement have been found (Dicheva et al., 2017). A meta-analysis conducted by Sailer and Homner (2020) showed that gamification can be an effective approach in learning contexts. Manzano-León et al. (2021) showed, by a systematic literature review, that gamification can be a valid learning strategy at different educational levels, affecting students’ performance, engagement, and motivation.

Also, Trinidad et al. (2021) pointed to an increase in the number of literature reviews summarizing the knowledge in gamification. These literature reviews showed that gamification has been applied at different educational levels, from primary school to higher education. More recently, Chen and Liang (2022) built a theoretical model to evaluate how gamification influences students’ study engagement. They applied questionnaire surveys to 187 university-level students in China to find that gamification influences students’ study engagement through the indirect effects of enjoyment and self-efficacy.

Online classes, far from being a novelty, were massively used in the late years due to the COVID-19 pandemic involving from younger students to higher education students. COVID-19 brought new challenges to education without professors and schools being prepared for it. With most face-to-face classes being replaced by online classes, almost all around the world, these challenges also created opportunities. Although now schools are mostly returning to a learning set prior to the pandemic, the advantages of online classes were noted by professors and schools’ staff.

The number of classes being shifted online is increasing regarding the pre-pandemic situation. But, as Raju et al. (2021) pointed, dealing with students’ engagement and motivation is a critical factor in online classes that needs to be considered. Online learning is still regarded as being less engaging than face-to-face classes (Bai, Hew, Gonda, Huang, & Liang, 2022). Most learners and instructors experienced stress while transitioning from face-to-face classes to online classes (Park & Kim, 2021).
To deal with these drawbacks, simple issues like motivating students to turn on their video cameras during online classes and why that is important have been addressed and strategies have been proposed (Castelli & Sarvary, 2021). Duggal, Singh, and Gupta (2021), during the COVID-19 pandemic, also found that online activities required more engagement, self-regulation, and interest from students. Technology powered by gamification strategies can improve motivation and engagement in online education.

Chans and Castro (2021) conducted a gamification experience with engineering students in online classes that showed that their autonomy and engagement was reinforced. Miškov (2021) presented preliminary research focused on the possibilities of implementing game elements into e-learning at university. Students were asked about the potential of using game elements in e-learning and about what motivates them to study online. Game elements were mentioned by 51.1% of the students as a driver for their motivation to attend online classes.

A study conducted by Raju et al. (2021) during COVID-19 lockdown used Google Classroom, social media tools like WhatsApp and Telegram, and online meeting platforms like Zoom, to allow a group of 56 post-graduate students to attend online classes. Their research showed that students were more motivated using a game-based learning platform, bringing competition among the students.

Portela (2022) presents the results of an experience with the TeachTeach paradigm that uses blended-learning, gamification, soft-skills, quiz and surveys, FC, and project base learning to create a learning environment for students. A case study was performed in a programming course online classes in the 2020/2021 academic year. In this study, 85% of the students classified the gamification approach as good or excellent. Regarding online classes, 60% of the students said they liked to attend these classes. They also considered TeachTeach ready or adapted to classes 100% online. Almost all students (98.15%) completed the course successfully. According to its author, one of the main contributions of this study was a detailed explanation of how gamification can be used and applied in online classes.

Bai et al. (2022) found that, by introducing the element of fantasy, students’ engagement can be increased. Their study aimed to enhance student behavioural engagement in online discussion forums in a gamified learning experience (at the university level in the 2020/2021 academic year, within COVID-19 pandemic). As students gradually lost interest and their participation in online discussions dropped after a few weeks, the new element, fantasy, was introduced into the original model. This new approach could better promote students’ engagement.

Fantasy can be seen as an environment that “evokes mental images of physical or social situations not actually present” (Malone & Lepper, cited by Bai et al., 2022). These authors also suggested that “embedding educational activities into a fantasy context enhances students learning motivation and engagement.” Bai et al. (2022) concluded that the inclusion of fantasy into gamification promotes student learning and improves the quality of online interaction.

The effect that gamified online learning has been investigated not only at the university level but also with younger students. Park and Kim (2021) conducted a study with 140 elementary and middle school students who suggested that gamified online learning has a positive impact on learner motivation and learning outcomes. Science Level, a platform used by public institutions in South Korea that offers gamified learning programs for science education for elementary, middle, and university students, was used in this study. It concludes that the platform affected positively learners’ motivation, self-efficacy, self-determination, career motivation, grade motivation, and understanding.

Several models and frameworks have been proposed to deal with gamification in online learning scenarios. The Octalysis framework (Chou, 2015) defines a set of eight fundamental behavioural motivators (core drives) that influence human activities. These core drives, presented in the form of an octagonal graph, can be drawn with an online tool (https://yukaichou.com/octalysis-tool/).

From this set of motivators, game elements that best enhance these motivators can be identified. The framework can, for a given application or system, identify the strongest and weakest behaviour motivators giving hints for the designers to act on them. Marisa et al. (2020) used the Octalysis framework to measure and evaluate students’ core drives in an online learning system.

This study, taken during COVID-19 pandemic, provided recommendations to optimize the development of online learning systems. Diena, Dian, Yana, Novian, and Muhammad (2021) also applied the Octalysis framework in Kahoot!, a game-based application, considered in this study as a gamified learning platform. The study involved lecturers using Kahoot! in university courses. The Octalysis audit method applied to Kahoot! showed that this platform has a balance between positive and negative motivation and between intrinsic and extrinsic motivation. The study allowed the authors to state some recommendations regarding an optimized use of the platform. This shows that Octalysis can be a relevant tool for auditing gamified learning applications.

As recent research shows, gamification can improve students’ engagement and motivation in online classes. This is a relevant result since online classes are becoming more usual and hybrid learning is now a part of the
learning set. This new reality made student engagement even more complex than before (Raju et al., 2021) forcing professors to find and use new approaches to deal with this issue.

Concerning the use of games and gamification within the FC approach, Smith, Legaki, and Hamari (2022) conducted a systematic review of the subject (including publications from 2015 to 2021) to conclude that games and gamification can have a positive effect on FC, with impact in academic achievement. Their study also reveals that gamification is more common in the FC in-class component compared to the out-of-class component.

The combination of the FC and TBL approaches with gamification can make an important contribution to rich and immersive online learning environments. It can also have a positive impact on students’ motivation and engagement with online classes. The FC approach, by itself, can even outperform gamified online classes, as the study by Ng and Lo (2022) reveals (the study was applied in adult education courses for business management during the pandemic). Therefore, it is expected that FC and gamification combined with TBL can impact online classes even more, leading to an increase in academic achievement.

1.3 Enhancing Face-to-Face Classes with the TBL Methodology

Even before the COVID-19 pandemic situation and the use of digital media that enabled non-F2F teaching, approaches were already being sought in teaching methodologies that could contribute to circumventing some of the rigidity of traditional teaching models that are based on the expository role to be played by the higher education professor, with students assuming a predominantly passive role in the pedagogical process (Oliveira, Lima, Rodrigues, & Pereira Júnior, 2018), and the term active methodologies appear in studies associated with concepts such as TBL, FC, and gamification (Lopes & Simões, 2022; Lopes et al., 2019, 2020).

In recent years, the search for active methodologies has intensified or is at least more active and capable of involving students in the teaching/learning process to make the process and transmission and acquisition of knowledge contained in the curricula more efficient. The set of methodological options goes in the direction of centering the teaching and learning processes on the student, and increasing their involvement (Becker & Lucas, 2021; Lourenço et al., 2022a,b; Morais et al., 2020, 2021c,d, 2022; Sá, Morais, & Almeida, 2021; Lopes & Simões, 2022), with the student himself/herself understood as a determining element in the whole process, on which he/she has a critical view, i.e. on which he/she can intervene (Espey, 2018).

The TBL is a collaborative approach to learning built-in groups, with the professor acting as a mediator in the whole process of transmission and creation of knowledge that is a sharing and a joint construction (Espinosa, Araujo, & Veit, 2019), which promotes students’ performance and self-efficacy (Zha, Wu, & Estis, 2021). Some allusions and studies refer to TBL as a community of practice, alluding to the notion of sharing, of shared construction of knowledge, a vision that is very appealing, for example in medical education (Burgess et al., 2019, Wu, Zha, Estis, & Li, 2022). TBL is a methodology that transforms small groups into “teams” (Burgess & Matar, 2020).

This approach can be used in a variety of settings, one of them being that of student adaptations to new challenges and is seen as a methodology for dealing with new and possibly more challenging situations by students, privileging small group teaching in a large group setting, as are the settings of classes with many students (Najdanovic-Visak, 2017).

We have already presented some contents that can bring us closer to understand what TBL is and that we can systematize as a specific structure of course design cut out seeking to promote active and collaborative learning, which combines individual involvement in team problem solving, improving students’ academic performance and self-efficacy. It is a special form of learning in which small groups are formed, and a specific sequence of individual work and group work is applied. Prompt feedback should be given to students to create a motivational framework, as students increasingly hold each other accountable for coming to class prepared and able to engage in an active role as contributors to the discussion of the content covered (Parrish, Guffey, Williams, Estis, & Lewis, 2021).

This active methodology implies that the course content is divided into specific sequenced elements, and students are assigned to permanent and diverse teams of five to seven students during the planned course, although later the number of teams may be contingent on the number of students in the course. TBL comprises a preparation phase in which students prepare autonomously by reading, watching videos, or doing activities, similar to what happens in FC. Then follows the preparation and readiness assurance process (RAP) including an assessment aligned to the preparation material and first taken as an individual (individual readiness assurance test [iRAT]).

Then this iRAT is repeated as a team (readiness assurance test [tRAT]), which must be followed by immediate feedback, appeals, and mini lecture conducted by an instructor. Students now have the basis set for engaging in the module to
go through the application activities. These should be guided by a 4S framework, i.e. focused on a meaningful problem; all teams are given the same problem; teams must make a specific choice to solve the problem; and team responses are revealed simultaneously Parrish et al., 2021.

A final phase of the learning process is application-oriented activities, which provide students with group application problem (GAP) tasks to deepen their understanding and to use the concepts to solve the problem(s) for discussion within the team and debate between teams (Michaelsen & Sweet, 2008). It is a characteristic of this active methodology that it allows students to apply knowledge to both individual and teamwork. Several studies prove that TBL is effective in higher education, reinforcing the growing movement towards the adoption of this methodology (Duffy, McCormack, O’Hanlon, & Seery, 2022) (Table 2).

Benefits of TBL methodology (Michaelsen & Sweet, 2008; Reimischel, Herring, Huang, & Minor, 2017): application of knowledge; engaging students; developing thinking skills; enriching learning; fostering teamwork, driving learning behaviours. TBL is primarily delivered F2F, and some questions may arise regarding synchronous and asynchronous interactions, reiterating the role of the professor/instructor as a mediator of interactions, discussions, and clarifications of doubts. According to the existing literature, TBL online can be an effective alternative to F2F, although adjusting to the technology is time consuming (Parrish et al., 2021).

TBL has been used incrementally in medical school courses, but its use is typically limited to certain courses or parts of courses, highlighting some limitations of this methodology (Rajalingam, et al., 2018), specifically if we want to implement TBL on a large scale, across different courses and disciplines, as the next logical step.

The approach of TBL methodology to e-Learning or B-Learning concepts is seen by some studies as a modified TBL methodology (Albarrak, Zakaria, Almulhem, Khan, & Karim, 2021), warning about some technological limitations in human interaction and consequently in teaching and learning processes.

To be successful in terms of achieving objectives, the TBL methodology must be accompanied by determining factors, including “team-centeredness” learning spaces, to foster active, collaborative learning, include the existence of an e-learning ecosystem, accordingly integrated to support all phases of the TBL process, and mandatory, include teaching teams in which experts in pedagogical process – TBL facilitators – co-teach with experts in subject matter – content experts (Rajalingam et al., 2018). The facilitation of the discussions during the application sessions can be very challenging, concerning ensuring conciseness and depth in the contents addressed (Huijbregts et al, 2022). Studies show a positive influence on learning outcomes using TBL if instructional modules with contents concerning this methodology are shared with students involved in the process (Wu et al., 2022).

### 2 Field Research and Results

This study implements a quantitative methodological approach, by applying a survey as a research instrument, which characterizes the investigated sample and presents a set of questions that cover the perception of higher education students towards active teaching methodologies (CF, TBL, and gamification).

Statistical analysis involved descriptive statistical measures (absolute and relative frequencies, means, and their standard deviations) and inferential statistics. The significance level to reject the null hypothesis was set at ($\alpha$) ≤ 0.05. Exploratory factor analysis, Cronbach’s internal
consistency coefficient alpha, Pearson correlation coefficient, and Mann–Whitney test were used. The normality of distribution of the variables was analysed non-normal distribution. Statistical analysis was performed with the software SPSS (Statistical Package for the Social Sciences), version 28.

This study included higher education students \((N = 88)\) from one higher education institution (HEI) in Portugal. Most students are male (93.2%) with an academic high school qualification (81%). The mean age is 22.8 years (Std. deviation = 6.4 years), ranging from a minimum of 17 years to a maximum of 49 years. A considerable proportion of the students having an area of study in the HEI is as follows: science, mathematics, and informatics, 70.5%; engineering, manufacturing, and construction industries, 29.5% (Table 3).

In Table 4, we can see students’ answers to questions related to their perception of the techniques used in the active methodologies of FC, TBL, and gamification (questions Q1–Q14). In bold values, we highlight the most frequent responses. However, the answers that motivated the highest levels of agreement were questions Q4 \((M = 3.54)\), Q6 \((M = 3.50)\), and Q7 \((M = 3.51)\), demonstrating that students tend to value the provision of videos recorded by the professor.

Question Q14 as indicated in Table 4 does not use the Likert scale to check the level of agreement of students about active methodologies, but it indicates that there is a possibility to implement in FC, e.g., in individual gamified assignments in e-learning environments and also use

<table>
<thead>
<tr>
<th>Table 3: Sample characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (mean; Std. deviation)</strong></td>
</tr>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Academic degree</td>
</tr>
<tr>
<td>High school</td>
</tr>
<tr>
<td>Undergraduate</td>
</tr>
<tr>
<td>Undergraduate degree in progress</td>
</tr>
<tr>
<td>Higher professional course (CTeSP)</td>
</tr>
<tr>
<td>Undergraduate</td>
</tr>
<tr>
<td>Knowledge area</td>
</tr>
<tr>
<td>Sciences, mathematics, and informatics</td>
</tr>
<tr>
<td>Engineering, manufacturing, and construction</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 4: Perception about active teaching methodologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1 – I can understand, in broad terms, what active teaching and learning methodologies are</td>
</tr>
<tr>
<td>Q2 – At some point in my academic journey, I perceived that the professor was applying active teaching methodologies</td>
</tr>
<tr>
<td>Q3 – I consider active teaching methodologies to be an asset in my learning process</td>
</tr>
<tr>
<td>Q4 – I consider it relevant that the professor makes his videos available on the e-learning platform, in addition to the textual content of the subject</td>
</tr>
<tr>
<td>Q5 – I think that in “some ways” the videos recorded by the professor will be more appealing, than reading a book, manual, or article in an e-learning environment</td>
</tr>
<tr>
<td>Q6 – Video allows me to revisit content when I do not quite understand it, which is harder to do during a face-to-face class</td>
</tr>
<tr>
<td>Q7 – The possibility of using videos as an aid in solving exercises to prepare for the tests/exams is a facilitating aspect</td>
</tr>
<tr>
<td>Q8 – Flipped classroom, gamification, and TBL are very labour-intensive teaching approaches in studies</td>
</tr>
<tr>
<td>Q9 – I understand the subject better when I do gamified activities</td>
</tr>
<tr>
<td>Q10 – I understand the subject better when I do practical activities and the professor focuses the face-to-face class on group activities</td>
</tr>
<tr>
<td>Q11 – Flipped classroom, gamification, and TBL are more interesting than traditional lecture classes</td>
</tr>
<tr>
<td>Q12 – Active methodologies are more effective because they allow me to better clarify my doubts with the professor and my classmates during the group work</td>
</tr>
<tr>
<td>Q13 – I prefer to do group activities in the classroom, with the professor as a mediator of knowledge</td>
</tr>
<tr>
<td>Q14 – I understand the subject better when gamified activities are carried out in</td>
</tr>
<tr>
<td>Individual work</td>
</tr>
<tr>
<td>Group work</td>
</tr>
<tr>
<td>In any case</td>
</tr>
</tbody>
</table>

1 – Totally disagree (%), 2 – partly disagree (%), 3 – partly agree (%), 4 – totally agree (%), M – mean, SD – Std. deviation. Bold value indicates the highest number of answers on the Likert scale.
gamification techniques in F2F classes with teamwork as foreseen in FC because students show in their majority (55.7%) a tendency to prefer both modalities of gamification implementation.

The analysis of the relational structure of the items of the scale of implementation of active teaching methodologies was performed through the exploratory factor analysis on the correlation matrix, with factor extraction using the principal components method followed by Varimax rotation. The common factors retained were those that presented an eigenvalue greater than 1. The validity of the factor analysis was done through the KMO test (0.656, reasonable), and Bartlett’s test (significance <0.001) and indicates acceptable values for its prosecution.

The factor analysis converged to a solution with five principal components that explain 66.9% of the total variance. In the rotated matrix, only items that presented saturation levels were considered >0.40. The components generated from the active teaching methodologies set of questions were designated as, (i) video advantages; (ii) active methodologies comprehension; (iii) advantages of mixed active methodologies; (iv) advantages of mixed active activities, and (v) class subjects’ comprehension.

In this study, two hypotheses were proposed, indicated below. Statistical analysis was done using the Mann–Whitney test for two groups, between the correlation of the components generated in the factor analysis and the independent groups.

**Hypothesis 1.** The students regardless of their course have the same perception about the teaching and learning process of the active teaching methodologies of FC, TBL, and gamification.

**Hypothesis 2.** The students regardless of the study area have the same perception about the teaching and learning process of the active teaching methodologies of FC, TBL, and gamification.

When comparing the two groups of students belonging to two different study areas of higher education, about the five components generated by the exploratory factor analysis, it was found that there are statistically significant differences ($p < 0.05$) between the groups indicated in bold in the table, in the perception of the advantages of recorded videos and the implementation of active teaching methodologies, as indicated in Table 6.

By statistically analysing the perception of students from different areas of study about the use of videos recorded by the teacher in FC, it is verified that students in Engineering, Manufacturing and Construction value more the advantages of recorded videos (median = 0.58) and the advantages of active teaching methodologies (median = 0.48) than students in Sciences, Mathematics, and Informatics (median = 0.04 and median = 0.11, respectively).

### 3 Solutions and Recommendations

The results indicate that even though students can perceive teaching methodologies listed in the same way, perceptions on the utility of videos – a major tutorial resource – are clearly influenced by courses they attend or more specifically by the scientific area of the courses they attend.

One major recommendation can be made, in line with what was proposed regarding the student-centred use of resources through an active methodology recurring to an isolated or broad approach on FC, gamification, or TBL that is characteristic of students, the learning objectives of a course, and the technical resources (hardware and software) that are used in active methodologies must be carefully monitored constantly enabling planning. So, in addition to content expertise, pedagogical expertise must be held on courses made available when using active learning methodologies.

**Table 5:** Mann–Whitney test for course types and group of students

<table>
<thead>
<tr>
<th></th>
<th>Video advantages</th>
<th>Active methodologies comprehension</th>
<th>Advantages mixed active methodologies</th>
<th>Advantages of mixed active activities</th>
<th>Class subjects comprehension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mann–Whitney U</td>
<td>823.000</td>
<td>826.000</td>
<td>774.000</td>
<td>792.000</td>
<td>716.000</td>
</tr>
<tr>
<td>Sig.</td>
<td>0.597</td>
<td>0.615</td>
<td>0.339</td>
<td>0.424</td>
<td>0.143</td>
</tr>
</tbody>
</table>

Grouping variable: current_course_degree.
As presented in the previous section of this article, the FC approach presents a higher efficiency in the lecturing practice (Amresh, Carberry, & Femiani, 2009; Kerr, 2015; Mason, Shuman, & Cook, 2013). However, the application of CF methodology together with other teaching practices such as gamification or TBL needs further field research to verify more clearly, which specific aspects of these teaching methodologies are effective when joined together.

Nowadays, gamification is a relevant topic under research. HEI is still under traditional practice in a new generation of students who are fully digital. The students are more prone to cooperate and by this mean – learn, if the HEI lecturing practices move into a new digital paradigm, the gamification means learn by playing, which can be a major contribution to the evolution of the classroom. The HEI has begun to configure new hybrid learning environments, where they plan to incorporate gamification to promote engagement during and after the classroom practice. In a hybrid lecturing scenario, this approach presents relevant positive results (Vélez, Verdugo, Mejía-Pesáñez, Veintimilla-Reyes, & Maldonado-Mahauad, 2020).

An innovative model for BeA (Blended e-Assessment) platform enables the implementation of FC with gamification (Mikic-Fonte, Llamas-Nistal, Caeiro-Rodríguez, & Liz-Domínguez, 2020). A personal learning environment is introduced where students and lecturers can develop, (re)use, and repurpose their own learning content (e.g., inquiry-based games feedback, assessment, micro-blogs), and mathematics modules can be accessed, created, remixed, learned, and reviewed in-class and out-class through rapid, personalized, and meaningful playful feedback (Lameras & Moumoutzis, 2015).

In the field of Engineering, the FC and gamification is demonstrated as a successful and inventive attempt to bring new lecturing practices for teaching and training Cisco Networking Academy tools set (Zhamanov & Sakhiyeva, 2015). Software engineering lecturing has the advantages of applying active learning, FC, gamification, and WAC (Writing Across the Curriculum) (Villagra, Benedetti, Bruno, Fernández, & Outeda, 2020).

The FIBER (Flipped Issue-Based Enquiry Ride) is a proposed pedagogical framework that integrates FC into the process of issue-based enquiry learning for social humanities education. Also, as a new approach, the G-FIBER (gamified-FIBER) blends FIBES with the concept of gamification. The result shows a significant increase in pedagogical effectiveness with the G-FIBER approach, thus proving the benefits of mixing FC with gaming applied to learning (Jong et al., 2021).

A case study was conducted, also, with the purpose of clearly identify and analyse the overall impact of gaming

<table>
<thead>
<tr>
<th>Table 6: Mann-Whitney test for study areas and groups of students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class subjects comprehension</td>
</tr>
<tr>
<td>Video advantages mixed active methodologies</td>
</tr>
<tr>
<td>Advantages mixed active methodologies</td>
</tr>
<tr>
<td>Active methodologies comprehension</td>
</tr>
<tr>
<td>Advantages active methodologies</td>
</tr>
<tr>
<td>Grouping Variable: study_area.</td>
</tr>
</tbody>
</table>
practices applied in an IES to understand the positive of impact of FC blended with gamification. The tools that were applied in the set were as follows: Kahoot!, Socrative, Quizizz, and Nearpods. These learning tools were used in the course of management with Google Classroom support and shared with other European lecturers through the AduLeT (Advanced use of Learning Technologies in Higher Education). Taking into consideration that this solution was tested under the pandemics scenario, this sharing was of extreme relevance for the adoption of better lecturing practices. The results presented were satisfactory involving a greater dynamic and interest during classes (Morais, Gonçalves, & Assis, 2021a).

Another example of a case study delivered to undergraduate students with majors in accounting, finance, marketing, and management. The results demonstrate a positive impact on the proposed course delivery with improvement over student's participation. However, some challenges were detected: in terms of technology and content delivery that were described by students and lecturers (Durrani, 2019). Finally, understanding the impact of the introduction of social learning environments (TBL) can be a final lever that combined with FC and gamification can lead to a higher engagement and improved learning results in students (Kiønig et al., 2021).

The FC blended with TBL will also be a relevant effort in the improvement of the learning experience. Research suggests the following results: 47% of the students were pleased with the organization of the course, whereas up to 33% of the students were displeased (in particular the female students). About 60% of the students liked the TBL in class, but about half of the students felt that the course lacked traditional lecturing. Finally, it was surprising that 44% of the students never or seldom read the textbook before class, while 74% watched the videos (Loftsson & Matthíasdóttir, 2019).

In an engineering course, the adoption of FC along with TBL is presented, and it analysed the results using the Florida Taxonomy of Cognitive Behavior and assessed the effectiveness of the implementation in achieving deeper learning. In addition, it reports on students' perception of the new course structure and their experience using TBL (Awatramani & Rover, 2015). A research attempt to fully understand the benefits and problems associated with the innovative practices of FC, PBL, gamification, serious games, workshop, software factory, playful resources, and scrum methodology is fully documented (Quaresma & Oliveira, 2021).

4 Future Research Directions

In the new era, in the current century, with a panoply of new trend technologies, students are emerged in technology, which is an important part of their daily routine, to rethink that teaching methodologies and approaches are of extreme relevance. To involve the students in a digital environment that works as a lever to the knowledge acquisition is a nowadays lecturer's concern. The literature of the state of art documents innovative approaches such as gamification, TBL, and others.

The aim is to manage all the possible technical innovative approaches aiming students' performance. A Flipped learning program is described, and its planning is presented with an integrated pedagogy in the pre-classroom, during the classroom, and post-classroom activities to achieve the objective of comprehensive knowledge and skills acquisition for improving the nursing practice during lecturing (Chaturvedi & Chaturvedi, 2022). Building adequate analytics can lead to a better understanding of the impact of the new lecturing approaches enabling the implementation of the best adaptive measures to achieve the goal of lecturing (Mehnen, Pohn, Blaickner, Mandl, & Dregely 2022).

The professor-centred model of education is moving into student-centred model and several innovative pedagogical solutions such as self-directed learning, game-based learning, FC, m-learning, and microlearning have been under research for the last decade. The introduction of interactive technologies among with new lecturing resources can improve the engagement and motivation to learn and perception of information (Tríchly, Zeman, & Podhradský, 2022).

A panoply of new technological approaches brings new opportunities to achieve the goal of a better lecturing practice. An educational interactive activity uses desktop immersive virtual reality (VR) to support the learning practice of the use of laboratory instrumentation (Paxinou, Mitropoulos, Tsalapatas, & Kalles, 2022). The creation of virtual leaning spaces is well accepted by the students, and the majority of them find the 3D visualization of the lecturing contents as important (Yano, 2022).

In the technology-enhanced-learning (TEL), the learning design (LD) research pretends to give support to lecturers in assisting their students for the achievement of intended learning objectives (ILOs) faster and more effectively. Some research studies focus on non-technical savvy lecturers that aim for efficient flipped learning scenarios, including Agile methodology, and this way provide a gamified learning environment to influence students’ engagement and motivation. An improvement of the LD can be the path (Hammami, Khemaja, & Ghannouchi, 2022). Some research is conducted with the connotation of FC and data mining technology. The FC teaching mode based on SPOC is presented (Tao & Wei, 2022).

It is also of great relevance to build student-oriented behaviour analysis models and perform performance
prediction with the support of machine learning dynamic Bayesian networks and build a better learning path planning after understanding the bidirectional influence mechanism between students and knowledge system (Liu et al., 2022). The chatbot technological solution can be also a lever for the efficiency of the FC approach. The tool can act as an aid to increase student's involvement in the preparation for a seminar, for example. All the data collected during the process of the work through the bot, material used, testing, and questions will enable the lecturer understanding if the students are well or not prepared for the next lesson (Varnavsky, 2022).

The main goal of achieving a higher motivation of the students is the key success on the hunt. The evolution of the FC is clearly moving in the direction of using several new technologies such as virtual reality, augmented reality, and artificial intelligence as technology supports the educational disruption needed to face the new age student's profile. It is clear in the literature review that these new levers will strongly increase student's engagement in the learning process (Mansoor, 2021).

5 Conclusion

Active teaching methodologies and digital teaching present themselves as an interesting alternative to traditional teaching models, especially in times when digital technology is widely disseminated and the need for the physical presence of professors and students in the same physical classroom is no longer necessarily mandatory for the realization of the teaching and learning process, especially in higher education. Meanwhile, new paradigms and challenges arise and the concerns of professors, students, and educational institutions, about the quality of teaching, whether in F2F class or e/b-learning are continuous and widely debated in academia and materialized in the scientific literature.

The pandemic period of COVID-19 sharply accelerated the process of implementing digital teaching, whether in the intensity of asynchronous classes on a videoconferencing platform, with the most varied resources and tools, or challenging professors and students to have to adapt quickly and forcefully to e-learning. However, this change has amplified the concerns about the efficiency and effectiveness of the existing teaching models, their methodology, and techniques. The current issue is no longer a lack of resources, especially digital resources, but how to properly apply this panoply of possibilities, computer resources, and teaching methodologies remains unclear.

This study aims to contribute by critically analysing experiences presented on the implementation of the active teaching methodologies discussed in this article. Meanwhile, active methodologies indicate the need for students to play a greater role in their teaching and learning process.

Meanwhile, as the future work, it is intended to develop an empirical study to explore with higher education institutions the practices and models that have been adopted for the implementation of active teaching methodologies. As the future work, it is intended to develop an empirical study to explore with higher education institutions the practices and models that have been adopted for the implementation of active teaching methodologies.

Funding information: The authors state no funding involved.

Conflict of interest: The authors state no conflict of interest.

References


Castelli, F., & Sarvary, M. (2021). Why students do not turn on their video cameras during online classes and an equitable and inclusive plan to encourage them to do so. Ecology and Evolution, 11, 3565–3576.


