# Chapter 6
# Evaluation of Implementation of Gamification and Active Methodologies to Flipped Classroom Model

María-Mercedes Rojas-de-Gracia
*https://orcid.org/0000-0002-5006-039X*
*University of Malaga, Spain*

Ana Esteban
*University of Malaga, Spain*

María Bentabol
*University of Malaga, Spain*

María Dolores Rodríguez-Ruiz
*University of Malaga, Spain*

María Amparo Bentabol
*University of Malaga, Spain*

Ana Paula Lopes
*https://orcid.org/0000-0003-1603-6959*

*CEOS.PP/ISCAP/P. Porto, Portugal*

Filomena Soares
*https://orcid.org/0000-0001-5203-9458*
*CEOS.PP/ISCAP/P. Porto, Portugal*

María del Mar Muñoz
*University of Malaga, Spain*

Rocío Caña-Palma
*University of Malaga, Spain*

Mariano Soler
*https://orcid.org/0000-0002-7928-6536*
*University of Malaga, Spain*

## ABSTRACT

*The use of the flipped classroom at HE has been very popular in recent years. However, recently a series of studies are appearing that question in a certain way the usefulness of this methodology to improve student learning. To shed more light on this dichotomy, this study has been carried out, which presents as its main strengths the fact that it is a longitudinal investigation, with a large sample of students from various subjects and from two different countries. Its findings confirm that the degree of student satisfaction when the flipped*

*classroom is applied with gamification and with active methodologies is very high, especially with regard to the use of Kahoot!, and the work of the teachers who apply them. Likewise, it is concluded that student satisfaction is slightly higher when the teachers who apply it do not do it alone, but rather do it collaboratively with other colleagues.*

Keywords: Flipped Classroom, Gamification, Game-Based Learning; Active Methodologies; Collaboration between Teachers; Moodle; Socrative; Higher Education.

## INTRODUCTION

In the past few years, different teaching/learning methodologies and pedagogical strategies for Higher Education (HE) have been proposed (Mareca & Bordel, 2019; Rojas-de-Gracia & Alarcón-Urbistondo, 2021). The technological development and digitalization of society have introduced many innovative methods (Bordel et al., 2019) with the purpose of increasing the efficiency of the educational process. Active and cooperative methodologies appear as the most effective forms of learning (De la Cruz Tomé, 2003). In this regard, there are several studies applied to HE for various subjects that show that this type of methodologies significantly improved the motivation of students and their final grades (Calderon & Passos, 2020; García-Holgado et al., 2021; Gros, 2008; Perez-Poch, 2019; Vergara, 2020). According to Rothman (2016), given the profile of the average HE students, they need a teaching methodology that is based on four pillars. The first of these is that the explanations have to be based on graphics, even if they are complex, rather than literature. This is because they are kinesthetic, experimental and practical learners, who prefer to learn by doing something rather than following directions or reading a text. Second, they need random access to the work material, that is, they do not like to follow a fixed order and prefer interconnected activities. Third, the materials should be provided in the form of short information pills, as the students need speed and instant gratification. Finally, they like to use interactive multimedia that allows them to interact with the content.

All this has made the use of active methodologies such as the flipped classroom and gamification models are among the most common alternatives for active and cooperative learning in the HE setting. In the last decade, there has been a shift from traditional didactic lectures promoting strategies that actively involve students, in the direction of a more interactive and meaningful learning environment (Guerreiro, 2020). This is where the objective of this work is framed: to analyze the degree of satisfaction of students with the strategy in an innovative didactic project based on the flipped classroom and gamification in a collaborative way. The secondary objective is to identify differences in student satisfaction based on the level of implementation of the different educational techniques. To be precise, we want to check if there are significant differences in satisfaction if the implementation of this pedagogical model is total or partial. In the first case, all the teachers of the same subject are coordinated and apply the same methodological model; and, in the second case, the teacher who teaches the subject acts in a more "solitary" way, without counting on the support of other colleagues.

## BACKGROUND

The flipped classroom method was developed by Bergmann and Sams (2012). The pioneers of this movement (chemistry teachers at Woodland Park High School in Colorado) recorded their lessons and posted them online, allowing students to access them remotely, with an attempt to counter the effects of students' high absenteeism levels. Therefore, the principal idea comes from reversing the traditional teaching paradigm, where the main phases of the teaching and learning process, such as classroom activities and homework, are reversed. The flipped classroom is organized differently: instructional content (e.g., pre-recorded video lectures) is assigned as homework (analyzed before coming to class) and time in class is spent working on problems, advancing concepts, and engaging in collaborative learning (Findlay-Thompson & Mombourquette, 2014). Moreover, the flipped classroom may contain several out-of-class activities, including readings, homework, and supplemental videos (Chen et al., 2014; Gilboy et al., 2015; White et al., 2017).

Many studies have been carried out on the effectiveness of the flipped classroom on students' academic performance in several subjects, such as the English language (Afzali & Izadpanah, 2021; Chang & Lan, 2021), Economics (Van Wyk, 2019), Science subjects (Doğan et al., 2021; Styers et al., 2018), Financial Mathematics (Lopes & Soares, 2018), Nursing (Joseph et al., 2021; Menegaz et al., 2018; Padilla et al., 2021), Mathematics (Suanse & Yuenyong, 2021), Chemistry (Fautch, 2015; Fung, 2017; Teo et al., 2014), Medicine (Dombrowski et al., 2018), Law (Liu, 2017), and Business Management (Senties Santos et al., 2021). According to Lichvar et al. (2016), the use of flipped classroom is an effective and active learning strategy with positive feedback from students. The flipped approach significantly improves students' interest in the lectured topics and their engagement in learning, compared with those taught using a traditional teaching approach (Afzali & Izadpanah, 2021; Rotellar & Cain, 2016). Instructors who used the flipped classroom model found that student academic performance significantly improved compared with other classroom models (Polat & Karabatak, 2021).

However, this method also has its criticisms, which have come from the hand of authors such as Bothwell (2018), who, according to a recent survey by the European University Association of 303 European universities and 43 higher education systems, the flipped classroom is ranked as the least useful model for improving student learning. In fact, he claims that less than 15% of European universities are strong advocates of the flipped classroom as a model for improving student learning. In his article, Bothwell cites James Conroy, deputy director of internationalization at the University of Glasgow, who argues that, although much is said about e-learning, the evidence to date can hardly replace that intellectual encounter that the more traditional forms of learning entail educational practice. There is also a stream of recent studies that highlight this methodology does not always achieve better results in academic performance (Gloudeman et al., 2018; Setren et al. 2021; Shih & Tsai, 2017).

Directly related to the flipped classroom is the so-called gamification. Gamification in education is a novel application of the conceptual elements of a game's design to non-ludic contexts (Deterding et al., 2011; Prieto Martín et al., 2014). In the educational environment, gamification is a set of initiatives oriented to increasing students' motivation for learning, applying proposals of playing experiences in formative contexts to promote a good environment for learning, minimizing the cognitive effort that they entail, and looking for greater involvement of students in a climate of competitiveness and cooperation (Glover, 2013). Gamification applied to education aims to increase students' motivation to achieve goals through the addition of the learning system of components related to the mechanics of games. Gamification should also lead to a change in student behaviour (Hamari & Koivisto, 2013). Therefore, gamification has several advantages, such as facilitating students to participate more in their learning process, be more motivated, understand better the taught concepts, construct their knowledge, and develop the connected competencies (Lopes et al., 2019). Further, direct interaction between the users and the establishment of a rewarding system made gamification widespread in HE (Varannai et al., 2017).

Despite negative associations to playing games, the use of games in the learning context has many benefits (Al Fatta et al., 2018). According to Palomares et al. (2017), gamification and other active methodologies increase student motivation and attention, even leading to higher marks. For instance, educators take advantage of applications such as Kahoot! to deliver learning content more innovatively. Kahoot! is very popular as it has a positive impact on student's motivation (Bicen & Kocakoyun, 2018). Among the major challenges in today's world is to keep students motivated and engaged in their learning path, which is why other non-traditional types of learning have been implemented to gain students' attention. Adding game elements to an inverted classroom can have a significant effect, improving student learning performance, motivation, and participation (Ekici, 2021).

Regarding collaboration in education, much has been written about the effects of the relationship between different levels of education (Del Castillo & Aguilera, 2018; Llamas, 2011; Portelance & Caron, 2016; Stoddard, Kewitt, & Danforth, 1997) and among higher education teachers and other non-teaching institutions (Bickel & Hattrup, 1995; Papalewis, 1995; Zeman & Hrad, 2014). However, there are hardly any relevant studies in which these effects are studied when it comes to collaboration between university teachers themselves. The study by Sánchez, Forés and Viccari (2011) stands out, which identifies the existence of a beneficial effect when collaborating in the application of teaching methodologies. Specifically, they indicated that getting involved in collaborative processes between teachers is not only a

source of learning in itself, but also opens the possibility of rediscovering and repositioning oneself in relation to what is taught and to the relationship with the students themselves. This collaboration today is much more feasible in earlier times due to the existence of virtual environments that provide spaces in which information is shared and worked together (Snowdon, Churchill & Munro, 2001).

Thus, in view of recent works that are questioning in a certain way the effects of the flipped classroom on student performance, this study aims to verify what happens in the case in which this methodology is combined with game-based learning and active methodologies. For this, the results are presented based on a longitudinal study that covers the 2017/2018 academic year to 2020/2021. In this period, the opinions of 725 students from different subjects, different degrees and from universities in two countries, which are Spain and Portugal, have been collected. In addition, secondly, this research compares whether there are differences in the degree of student satisfaction depending on whether the teachers have acted collaboratively or not. Therefore, the two research questions of this study arise:

> **Research Question 1 (RQ1)**: Investigate the degree of student satisfaction when the flipped classroom is applied with gamification and with active methodologies.
>
> **Research Question 2 (RQ2)**: Identify if there are differences in student satisfaction between the collaborative model and the non-collaborative model when the flipped classroom with gamification and active methodologies is applied.

## CONTEXT OF THE RESEARCH

### Innovative Teaching Project Context

This experience in educational innovation was initiated in the academic year 2015-2016 with the Educational Innovation Project PIE15/174 funded by the University of Malaga (UMA). The project has been renewed, with the incorporation of more teachers and subjects from both the UMA and the Polytechnic University of Porto, until the current PIE19/156. It consists of the application of the inverted classroom pedagogical model, with the intention to help students take responsibility for their learning. University students are expected to be capable of being masters of their time and effort, so the project consists of giving voice to the students and letting them be the main actor of the class, which is gradually configured according to the same development that they require and propose (García-Barrera, 2013). The more the learner is involved in the learning process, the more effective the learning process will be. "Learning by learning" improves learning because it increases the number of cognitive actions performed by learners (Dewey, 1916, 1929).

However, this conception of learning has its pitfalls. For example, in universities with many students per classroom, it is difficult to monitor the progress of each student and their degree of assimilation to new subject content, so the flipped classroom can be seen as "a framework that ensures that students receive a personalized education adapted to their individual needs" (Bergmann & Sams, 2012). This change in the way of teaching requires adaptation on the part of the teacher. Their extensive scientific and technical training must be complemented with specific training for teaching and the development of new materials (Cebrian, 1998).

To discover the implications of the project's implementation, the teachers give a questionnaire to the students to determine their degree of satisfaction with the model. The analysis of the information from these surveys, as well as from the academic results of students over the years has made progress in achieving the objectives set out with the PIEs: students' motivation and autonomous learning.

The flipped classroom pedagogical model has been incorporated into classrooms over the years and new teachers and subjects have been added. Therefore, it has not been possible to fully apply this methodology in all cases, but there are different levels of progress. Likewise, the variety of degrees and subjects involved makes it necessary to adapt to this methodology in different ways, which basically gives rise to two different scenarios: subjects in which the teacher had at least one colleague from the same subject or related subjects

with whom to share experiences and subjects in which the teacher was the only teacher who applied this methodology and who, therefore, could not share resources or experience with other colleagues.

## Educational Methodologies Used for the Application of the Flipped Classroom

In view of the above, it is advisable to create a separate description of the implementation of different educational techniques in two groups: on the one hand, the subjects in which there has been collaboration between teachers, which we will call "collaborative mode", and the other group in which this did not exist, which we will call "non-collaborative mode".

### *Collaborative Modality*

In this group of subjects, different ICT educational techniques have been implemented, such as Kahoot!, Socrative, and other active methodologies through the Moodle platform.

1. **Kahoot!** is a very useful tool, available in App or web, that allows creating quizzes to make evaluations in real-time, within the class, with immediate feedback and the results and ranking of the students, which stimulates motivation. Kahoot! is an activity carried out in class in this set of subjects, to determine the degree of assimilation of concepts that students have acquired by studying independently, through the material provided by the teacher. The student must prepare the lesson, available on the Moodle platform of the Virtual Campus and at the beginning of the next class, the teacher makes a questionnaire through this application to find out the degree of learning achieved by the students and detect possible difficulties. The results obtained by the students in this questionnaire are a part of the continuous assessment grade, which makes this not only a learning technique but also a method of evaluation.
2. Other tools in the field of gamification have been used to dynamize the classes and add to the relationship with the student, such as the design of a Trivia game on the subject's content. The **Socrative** tool was used for the elaboration of this activity and a bank of questions from different lessons of the syllabus was elaborated. Students were encouraged to play in groups, a random competition of questions and answers, between the different students in the group.
3. **Moodle platform** has been used as an active learning tool, as it is available in academic institutions. It is based on free software that favours blended learning, a model that combines face-to-face teaching with virtual teaching. According to Prendes (2009), it is an idea that is developed a lot in HE, the teacher plays a dual role as trainer and tutor, combining the skills of one and the other in different learning environments. Although there are many platforms, the study conducted by this author indicates that 85.1% choose Moodle. This virtual platform offers teachers and students a range of tools such as questionnaires, chats, forums, workshops, databases, glossaries, wikis, and interactive lessons.

   The following Moodle tools are used in the subjects of this group: Homework, Knowledge Test, Interactive Lesson, and Doubts Forum.

   a. The **"Homework"** activity allows collecting students' work, in different formats, such as exercises or resolution of practical cases. Additionally, "Homework" can be evaluated and comments can be made online, facilitating teacher's work and communication with students. In more practical subjects, students are given a lot of homework and they work on the materials outside of class, reserving class time to resolve doubts. It is problem-based learning. Further, the activity "Homework" is used for teamwork, which is among the most important competencies to be acquired as it will be used in professional activities.

   b. The Moodle **"Knowledge Test"** is also among the key pieces in the adaptation of this methodology. The "Knowledge tests" are built from a bank of questions, previously created by a group of the project's teachers. There are two types of tests: self-evaluations and regulated exams

of the subject. The first ones are proposed to the student at the end of each lesson with basic and advanced concepts so that the student can self-evaluate the level of assimilation of the concepts acquired and check if it is necessary to revise some concepts that are not completely assimilated. On the other hand, the regulated exams contain questions from all lessons to be evaluated and the grade is obtained as a part of the student's continuous evaluation.

c. Another Moodle tool used for the adaptation of the flipped classroom methodology is the **"Interactive Lesson".** This allows presenting the subject matter of the course by branching it in the form of content pages that end in a question or small quiz that students must answer. The activities depend on the student's answer: if it is correct, they will receive a comment to that answer and will be taken to the next page of the "Interactive Lesson" to continue improving the understanding of the topic. If the answer is incorrect, they will return to the content they have not finished assimilating, so that they can review it. All the lessons of the program are presented to the students through this resource, accompanied by videos and diagrams, which allows them to determine their degree of progress in each lesson and to go back to it when they consider it necessary. It is a very useful tool that allows paying attention to the diversity of students and the possibility of adapting to the learning of each student so that they can learn at their own pace.

d. Finally, both teachers and students participate in the **"Doubts Forum"**. This activity consists of a forum where students (and teachers) can expose doubts, difficulties, and suggestions regarding the functioning of the subject and/or course. Moreover, this activity is useful because:(i) students can raise their doubts outside the classroom schedule of the subject; (ii) it favors the participation of the most introverted students since they are usually not active in class, and this tool gives them "anonymity" which helps lose the fear of participation ; (iii) it is interesting for both students and teachers to encourage the latter's interest in the forum since the questions and issues of the forum can be unknown to the teachers; (iv) a record of each forum is kept, allowing users the opportunity to review its content at any time.

### *Non-collaborative Modality*

In this type of subjects, ICT learning techniques such as Kahoot! and/or ICT tools in the Moodle system have also been implemented, such as the "Homework", the "Interactive Lesson", and the "Doubts Forum", as well as videos and interactive PDFs. These learning techniques and Moodle tools have been used for the same purpose as in the subjects where all the groups and the teachers have implemented the flipped classroom methodology in the whole subject. Additionally, for the practical classes of one of these subjects, a series of videos has been uploaded to the virtual campus of the subject, elaborated by the teachers, where the necessary theoretical concepts are explained. Also, as the exemplification of the steps to be followed to carry out the tasks and exercises of the practical classes.

Another resource used for these practical classes has been interactive PDFs that are uploaded to the virtual campus. They consist of files that gather images in three dimensions (3D images) of the collection of crystallographic solids of the subject of Crystallography and Mineralogy taught in the first year of the Chemistry Degree at the UMA. The interactive PDFs were obtained from the three-dimensional virtual models of the solids, acquired using the photogrammetry technique (Pérez-Ramos et al., 2021). In these interactive PDFs, the student can rotate, establish longitudinal and angular measurements, draw, and note the elements of symmetry, crystalline forms, crystalline system, making the PDF an experience of physical reality and allowing the teacher to evaluate the student's work. The interactive PDFs are uploaded to the virtual campus of UMA, available to students before, during, and after the practical classes. Moreover, these interactive PDFs can be used as a material to evaluate the students in a non-face-to-face way.

## METHODOLOGY

From the beginning of the implementation of this experience of educational innovation and throughout the period of its development, surveys have been passed to students to determine their degree of satisfaction with the flipped classroom model. These surveys were passed by the teachers of the different subjects who, in turn, are the authors of this study. All students were of legal age and the anonymity of the response and

the exclusive use for academic purposes was guaranteed. Since teachers encouraged and cared for students to fill out the survey, the so-called "non-response bias", which is one of the limitations of any survey-based study, was minimized.

Specifically, a questionnaire consisting of 13 questions was designed. These were divided into four blocks on different aspects of the project: adequacy, comparison, usefulness, and general assessment. The first block included two questions, hereinafter Q, on the appropriateness of the way in which the materials could be accessed (Q1) and the resources used (Q2). The comparison block included two questions, one aimed at comparing the use of videos and PowerPoint presentations as opposed to the traditional classroom (Q3), and the other to compare the dynamics of the classes as opposed to traditional practical classes (Q4). The third block, that of usefulness, was the broadest as it consisted of five questions: usefulness of the methodology for not abandoning the subject (Q5), for understanding the contents (Q6), for improving performance (Q7), for autonomous learning (Q8), and for assimilating the contents (Q9). Finally, four questions were included for the general assessment of the clarity of the objectives (Q10), Kahoot! (Q11), the teacher who taught the class (Q12) and the general dynamics of the classes (Q13). All these questions were formulated using a Likert scale from 1 to 5, where 1 indicated a negative opinion and 5 a positive one.

Once the questionnaire was designed, data were collected. This took place at the end of the academic years 2017/2018, 2018/2019, 2019/2020, and 2020/2021 in diverse subjects, ranging from subjects such as Accounting to subjects such as Crystallography and Mineralogy. These subjects belong to several degrees of the Universities of Málaga (Spain) and the Politécnico do Porto (Portugal). The flipped classroom's pedagogical model was applied in all of them. The data for this study were extracted from nine subjects. Four teachers implemented this innovative teaching in the whole subject, and five teachers did it partially, either by only in a part of the subject or by using some available methodologies (gamification, Moodle resources, etc.). In total, 725 useful surveys were collected, 448 of which corresponded to the total modality and 277 to the partial modality.

On the other hand, to achieve the objectives proposed here, two types of analysis have been carried out. The first one consists of general descriptive analysis, considering all the students, without distinguishing between the two modalities. The distinction between two ways of applying the flipped classroom is made in the second analysis. In both analyses, the mean, median, maximum value, minimum value, and the range of variation are obtained for subsequent processing and interpretation.

## RESULTS

### General Results

Table 1 presents the results in a general descriptive form. The first thing that stands out when observing this table is that all the answers are valued with a mean above 3.7, which is well above the average, given that the maximum value is 5. This is indicative of the satisfaction that students get when the subject is taught using flipped classroom and would explain why its application is widespread in HE.

*Table 1. The main statistical values. General sample*

| | **Q1** | **Q2** | **Q3** | **Q4** | **Q5** | **Q6** | **Q7** | **Q8** | **Q9** | **Q10** | **Q11** | **Q12** | **Q13** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean value | 3.70 | 4.02 | 3.93 | 4.05 | 3.93 | 3.90 | 3.82 | 4.00 | 4.01 | 4.27 | 4.34 | 4.44 | 4.12 |
| Standard deviation | 1.40 | 0.81 | 0.99 | 0.93 | 1.01 | 0.99 | 1.01 | 1.00 | 0.83 | 0.75 | 0.86 | 0.81 | 0.78 |
| Median value | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 5.00 | 5.00 | 4.00 |
| Minimum value | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Maximun value | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Range | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |

*Source: Own elaboration*

Analyzing the data in more detail, it can be seen that the highest values are obtained in the general assessment block. In fact, three of the questions in this block (Q10 to Q13) occupy the top positions. Specifically, the highest score is obtained when it comes to evaluating the teachers. In the second place, they value very favorably the use of Kahoot! And, in the third place, they value very positively the clarity with which the teachers explained the objectives with the application of this methodology (Table 1). Once again, it is confirmed that, without going into details, the students are very satisfied with the innovation project.

Despite the good general evaluations, certain aspects achieve not as high scores. The worst-rated aspect is accessibility to resources (Q1), which indicates that students have had some problems when it comes to viewing and downloading the material made available by the teaching staff. However, this is the aspect wherein there is the greatest standard deviation, which means that not all students have perceived this difficulty in the same way. Aspects related to the usefulness of the methodology for the understanding of the contents (Q6) and the promotion of autonomous learning (Q8) would also be at the bottom of the considered aspects. However, we cannot lose sight of the fact that they achieve high scores (Table 1).

All aspects of the project present the maximum possible values, i.e., a 5, and the minimum possible 1, so the range of variation in all cases is 4 (Table 1). It is noteworthy that the median value for all the questions is 4, except when it comes to rating the use of Kahoot! (Q11) and the general evaluation of the teacher (Q12), which reaches the maximum 5 in both cases. A very high average in both cases reaffirms the idea that gamification, in this case through Kahoot!, is an instrument that increases student satisfaction with their learning. In summary, the answer to the RQ1 is that the degree of student satisfaction when applying the flipped classroom with gamification and active methodologies is very high, especially with regard to the use of Kahoot! refers, and to the work of the teachers that apply them.

## Collaborative Modality Vs. Non-collaborative Modality

Table 2 shows the results of the second analysis proposed in this work, which consists of comparing the same descriptive statistics as in the general analysis, but distinguishing according to whether the pedagogical model was applied collaboratively or alone. It is observed that, in nine of the 13 analysed aspects, there is a better evaluation of the results in the collaborative modality. The lowest mean values obtained in the non-collaborative modality are in the adequacy block (Q1-Q2), as well as the greatest difference between the mean values obtained in both forms of application, in the collaborative modality, 0.72 points more. However, as was the case in the overall analysis, the standard deviation presents the highest values in the two cases, indicating heterogeneity of students' opinions on this aspect.

*Table 2. The main statistical values. Collaborative and non-collaborative modality*

| | **Q1** | **Q2** | **Q3** | **Q4** | **Q5** | **Q6** | **Q7** | **Q8** | **Q9** | **Q10** | **Q11** | **Q12** | **Q13** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COLLABORATIVE MODALITY | | | | | | | | | | | | | |
| Mean value | 3.98 | 4.04 | 3.89 | 4.07 | 3.98 | 3.95 | 3.88 | 4.03 | 3.96 | 4.33 | 4.38 | 4.58 | 4.11 |
| Standard deviation | 1.24 | 0.81 | 0.99 | 0.91 | 0.93 | 0.92 | 0.96 | 0.95 | 0.84 | 0.69 | 0.81 | 0.66 | 0.78 |
| Median value | 2.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 5.00 | 5.00 | 4.00 |
| Minimum value | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Maximun value | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Range | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| NON-COLLABORATIVE MODALITY | | | | | | | | | | | | | |
| Mean value | 3.26 | 3.99 | 3.99 | 4.03 | 3.83 | 3.83 | 3.72 | 3.95 | 4.09 | 4.17 | 4.27 | 4.21 | 4.14 |
| Standard deviation | 1.52 | 0.81 | 0.99 | 0.96 | 1.12 | 1.12 | 1.08 | 1.08 | 0.82 | 0.82 | 0.92 | 0.97 | 0.77 |
| Median value | 3.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 5.00 | 5.00 | 4.00 |
| Minimum value | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 2.00 | 1.00 | 1.00 | 1.00 | 2.00 |
| Maximun value | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Range | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 3.00 | 4.00 | 4.00 | 4.00 | 3.00 |

*Source: Own elaboration*

Next in importance in terms of the supremacy of the collaborative modality is the evaluation of the teaching staff (Q12) (4.58 vs. 4.21, Table 2). Both aspects lead us to think that the implementation of collaborative work allows us to have more and better materials that are also more accessible to the students, and a greater homogeneity is achieved in different subjects. In turn, when the methodology is jointly applied to the same subject, it is possible to exchange experiences. Thus, when the flipped classroom is applied by a single teacher to a group of students, it may involve a greater workload without being able to share and compare their experience with other colleagues. Paradoxically, in two of the aspects evaluated in the non-collaborative modality, the usefulness for the assimilation of contents (Q9) and the general evaluation of the methodology (Q13) have a minimum value of 2, when, in the rest of the aspects in both modalities, they present the minimum possible value 1.

Figure 1 shows the comparison by blocks or aggregate results and not by specific aspects. As can be seen, the highest evaluation corresponds to the results of the general assessment, obtaining the highest mean and the lowest standard deviation. Once again, it is corroborated that the students obtain great satisfaction with the application of this methodology. The second best-positioned block is that of comparison, that is, when they are asked to compare their satisfaction with their experience with the methodology in traditional classes.

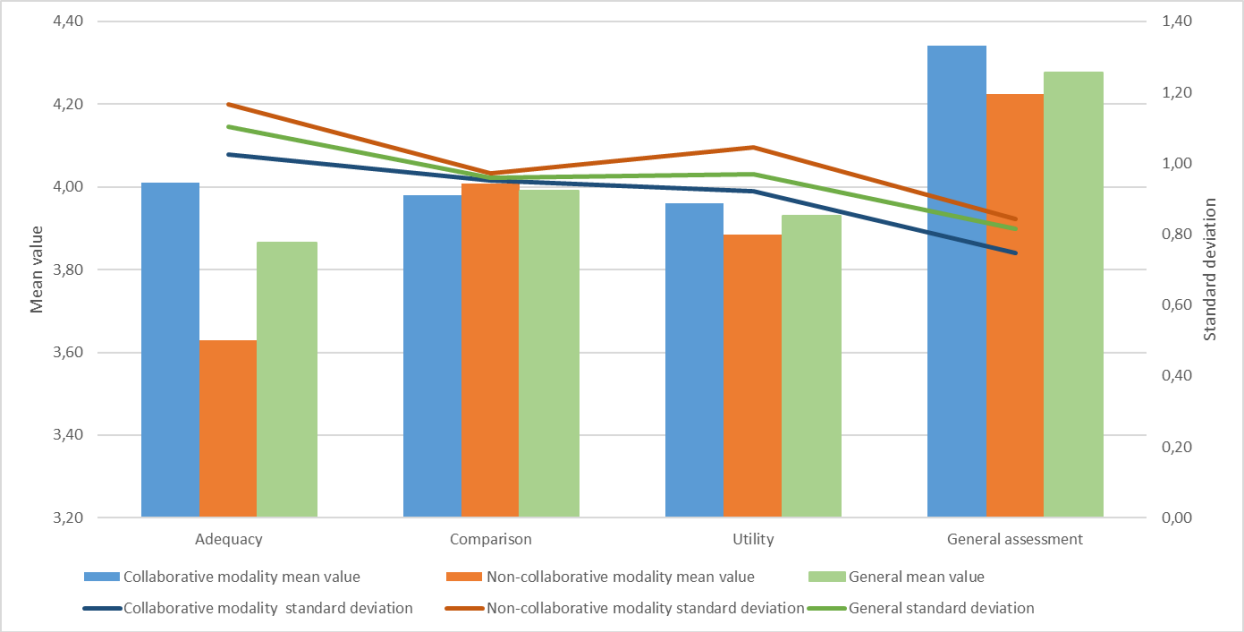


*Figure 1. Comparison of aggregated results*
*Source: Own elaboration*

On the other hand, the adequacy block presents the lowest mean value and the highest standard deviation, as has become evident throughout the study, and this is an aspect that needs to be improved. Finally, also in the analysis carried out by blocks, the supremacy of the collaborative modality over the non-collaborative modality is evident, except in the case of the comparison with the traditional methodology, although with a very small difference. In summary, and responding to RQ2, these results indicate that student satisfaction when the flipped classroom is applied with gamification and with active methodologies is slightly higher in the collaborative mode and in the non-collaborative model.

## DISCUSSION

This research has made it clear that the high level of satisfaction that students get when the subject is taught using flipped classroom and would explain why its application is widespread in HE, as concluded by numerous studies (Al-Samarraie et al.; 2019; Chen et al., 2018; McLaughlin et al., 2013; Perterson, 2016; Ritzhaupt, 2018; Sommer & Xiu et al., 2018). In other words, this work contradicts the current of studies that, like those of Bothwell (2018), Gloudeman et al. (2018) Setren et al. (2021) and Shih and Tsai (2017)

do not see so clear the benefits of this type of methodology. In fact, the average acquired in all the survey headings shows a value well above the average, which shows that the students are satisfied with this pedagogical model. Among the headings with a high or very high degree of student satisfaction and the desire to repeat the activity more often, those related to the applications Kahoot! and Trivial, examples of gamification used in learning, are the best rated. This fact comes to support what has already been proven in some studies, showing that game-based learning is among the best educational methodologies to implement in the flipped classroom (Ekici, 2021; Gómez-Carrasco et al., 2020; Huang & Hew, 2018; Hung, 2018; Parra-González et al., 2020; Sailer & Sailer, 2020; Toriz, 2019; Zamora-Polo, 2019).

Another remarkable aspect that can be deduced from the students' answers is the high valuation that they give to the teachers who teach the subjects using flipped classroom, which are close to the maximum value. Most of the answers to the question in which the valuation of the teachers who teach the subjects using flipped classroom is made are close to the maximum value. This reinforces the idea that satisfaction with a subject is directly related to the way it is taught and the teacher who teaches it. In other words, what both Benedito (1991) and Santos et al. (2017) affirm that the university teacher has to become a mediating agent, designing learning environments, continually looking for the way for students to learn autonomously, which requires them not only to have a series of pedagogical competences, but also a good management of technologies and educational resources. All of them are characteristics of the application of game-based learning and of the active methodologies applied to the flipped classroom.

The fact that, in general, the values of least satisfaction are those related to the adequacy of the materials, especially in the non-collaborative modality reinforces the results found by Shibukawa and Taguchi (2019). These authors believe that it is vitally important that teachers design a comprehensive flipped classroom model, so that the student maximizes the performance of the preparation time before class. Obviously, this includes the appropriateness of the way in which the materials could be accessed (Q1) and the resources used.

Finally, the best results in terms of student satisfaction with the application of the teaching methodology described in this work when teachers apply it collaboratively confirm the findings of the study by Sánchez, Forés and Viccari (2011). In other words, there are indications that the involvement of teachers in collaborative processes is a source of learning that allows improving the relationship with students and influencing their degree of satisfaction.

## CONCLUSIONS

The use of the flipped classroom methodology in HE has been very popular in recent years. However, recently some studies have appeared that question the usefulness of this methodology to improve student learning. With the aim of shedding more light on these doubts, this study has been carried out, which presents as its main strengths the fact that it is a longitudinal investigation, with a large sample of students from various subjects and from two different countries. The findings of the same confirm that the degree of satisfaction of the students, when the flipped classroom is applied combined with gamification and with active methodologies, is very high, especially with the use of Kahoot!, and, on the other hand, with the work of the teaching staff who apply them. In other words, this study is aligned with the research that supports the benefits of applying the flipped classroom. Likewise, it is concluded that student satisfaction is slightly higher when the teachers who apply it do not do it alone, but rather do it collaboratively with other colleagues.

These results have practical implications. Obviously, using these and other tools does not guarantee the good results of this model. Indeed, the most important thing is that the student feels involved / motivated in the learning process. Some students do not need any kind of motivation as they have already acquired the learning process, but most of them need to improve motivation and consider themselves a fundamental part of the learning process. However, these results indicate that the application of the flipped classroom with gamification, such as Kahoot!, and with active methodologies helps to increase student satisfaction,

so its use is recommended. Logically, some students prefer the traditional method of teaching to the flipped model because they consider that it means more work on their part. Another implication to highlight is the convenience of teachers applying this methodology in collaboration with other colleagues when this is possible.

Although the high scores in the degree of student satisfaction allow to draw conclusions by themselves, it would be interesting to replicate this study with the incorporation of a control group with which to contrast the results found. In this way, not only satisfaction with the methodology but also student performance could be compared depending on whether the flipped classroom has been applied or not.

## REFERENCES


Afzali, Z., & Izadpanah, S. (2021). The effect of the flipped classroom model on Iranian English foreign language learners. *ngagement and motivation in English language grammar*. *Cogent Education, 8*(1), 1870801.

Al Fatta, H., Maksom, Z., & Zakaria, M. H. (2018). Game-based learning and gamification: Searching for definitions. *International Journal of Simulation: Systems, Science and Technology, 41*, 1-5.

Al-Samarraie, H., Shamsuddin, A., & Alzahrani, A. I. (2019). A flipped classroom model in higher education: A review of the evidence across disciplines. *Education Tech Research Development, 68*(3), 1017-1051.

Benedito, V. (1991). *La formación del profesorado universitario.* Madrid, Spain: Subdirección General de Formación del Profesorado. MEC.

Bergmann, J., & Sams, A. (2012). *Flip your classroom: Reach every student in every class every day*. Washington, DC: EEUU: International Society for Technology in Education.

Bicen, H., & Kocakoyun, S. (2018). Perceptions of students for gamification approach: Kahoot as a case study. *International Journal of Emerging Technologies in Learning, 13*(2), 72-93.

Bickel, W., & Hattrup, R. A. (1995). Teachers and researchers in collaboration – Reflections on the process. *American Educational Research Journal, 32*(1), 35-62.

Bordel Sánchez, B., Alcarria Garrido, R. P., & Robles Valladares, T. E. (2019). Industry 4.0 paradigm on teaching and learning engineering. *International Journal of Engineering Education, 35*(4), 1018-1036.

Bothwell, E. (2018). Flipped classroom struggles to catch on in Europe. Retrieved from Retrieved from https://www.timeshighereducation.com/news/flipped-classroom-struggles-catch-europe

Calderon R., & Passos O. M. (2020). A study on the active methodologies applied to teaching and learning process in the computing area. In *IEEE Access* (vol. 8, pp. 219083-219097). Adelaide, Australia: IEEE Xplore.

Cebrián, M. (2001). Las nuevas tecnologías de la información y la comunicación para la mejora del prácticum en la formación inicial de profesores. Retrieved from http://webs.uvigo.es/poio/pdf/cid0.pdf

Chang, M. M., & Lan, S. W. (2021). Flipping an EFL classroom with the LINE application: Students' performance and perceptions. *Journal of Computers in Education, 8*(2), 267–287.

Chen, M. H., Chao, Y. C. J., & Hugn, H. T. (2018). Learning in a flipped English classroom from university students' perspectives. In *Proceeding of the 6th International Conference on Information and Education Technology* (pp. 33–37). New York, USA: Association for Computing Machinery.

Chen, Y., Wang, Y., Kinshuk, & Chen, N. S. (2014). Is FLIP enough? or should we use the FLIPPED model instead? *Computers and Education, 79*, 16–27.

De la Cruz Tomé, M. A. (2003). Necesidad y objetivos de la formación pedagógica. *Revista de educación, 331*, 35-66.

Del Castillo, M. T. G., & Aguilera, A. (2018). Dialogical collaboration among teachers of different education levels. *Remie-Multidisciplinary Journal of Educational Research, 8*(3), 234-258.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining "gamification." In *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments*. New York, USA: Association for Computing Machinery.

Dewey, J. (1916). *Democracy and education, an introduction to the philosophy of education*. New York, USA: The MacMillan Company.

Dewey, J. (1929). *Experience and Nature*. London: George Alen and Unwin.

Doğan, Y., Batdı, V., & Yaşar, M. D. (2021). Effectiveness of flipped classroom practices in teaching of science: A mixed research synthesis. *Research in Science and Technological Education*, 1–29.

Dombrowski, T., Wrobel, C., Dazert, S., & Volkenstein, S. (2018). Flipped classroom frameworks improve efficacy in undergraduate practical courses—A quasi-randomized pilot study in otorhinolaryngology. *BMC Medical Education, 18*(1), 294.

Ekici, M. (2021). A systematic review of the use of gamification in flipped learning. *Education and Information Technologies, 26*(3), 3327–3346.

Fautch, J. M. (2015). The flipped classroom for teaching organic chemistry in small classes: Is it effective? *Chemistry Education Research and Practice, 16*(1), 179–186.

Findlay-Thompson, S., & Mombourquette, P. (2014). Evaluation of a flipped classroom in an undergraduate business course. *Business Education & Accreditation, 6*(1), 63-71.

Fung, F. M. (2017). Adopting lightboard for a chemistry flipped classroom to improve technology-enhanced videos for better learner engagement. *Journal of Chemical Education, 94*(7), 956–959.

García-Barrera, A. (2013). El aula inversa: Cambiando la respuesta a las necesidades de los estudiantes. Avances en supervisión Educativa. *Revista de la Asociación de Inspectores de Educación de España, 19*, 1–8.

García-Holgado, A. Vázquez-Ingelmo, A., García-Peñalvo F. J., &. Conde, M. R. (2021). Improvement of learning outcomes in software engineering: Active methodologies supported through the Virtual Campus, *IEEE Revista Iberoamericana de Tecnologias del Aprendizaje, 16*(2), 143-153.

Gilboy, M. B., Heinerichs, S., & Pazzaglia, G. (2015). Enhancing student engagement using the flipped classroom. *Journal of Nutrition Education and Behavior, 47*(1), 109–114.

Gloudeman, M. W., Shah-Manek, B., Wong, T. H., Vo, C., & Ip, E. J. (2018). Use of condensed videos in a flipped classroom for pharmaceutical calculations: Student perceptions and academic performance. *Currents in Pharmacy Teaching and Learning, 10*(2), 206-210.

Glover, I. (2013). Play as you learn: Gamification as a technique for motivating learners. In *Proceedings of the world conference on educational multimedia, hypermedia and Telecommunications* (pp. 1999-2008). Florida, USA: AACE.

Gómez-Carrasco, C. J., Monteagudo-Fernández, J., Moreno-Vera, J. R., & Sainz-Gómez, M. (2020). Evaluation of a gamification and flipped-classroom program used in teacher training: Perception of learning and outcome. *Plos One, 15*(7), e0236083.

Gros, B. (2008). *Aprendizajes, conexiones y artefactos*. Barcelona, Spain: Gedisa.

Guerreiro, M. P. (2021). Implementation and Evaluation of Team-Based Learning in a Pharmacy Law and Ethics Module. *Pedagogies for Pharmacy Curricula* (pp. 133-159). Hershey, Pennsylvania: IGI Global.

Hamari, J., & Koivisto, J. (2013). Social motivations to use gamification: An empirical study of gamifying exercise. In *ECIS 2013. Proceedings of the 21st European conference on Information Systems* (1-12). Utrecht, The Netherlands:AISel.

Huang, B., & Hew, K. F. (2018). Implementing a theory-driven gamification model in higher education flipped courses: Effects on out-of-class activity completion and quality of artifacts. *Computers and Education, 125*, 254–272.

Hung, H. T. (2018). Gamifying the flipped classroom using game-based learning materials. *ELT Journal, 72*(3), 296–308.

Joseph, M. A., Roach, E. J., Natarajan, J., Karkada, S., & Cayaban, A. R. R. (2021). Flipped classroom improves Omani nursing students performance and satisfaction in anatomy and physiology. *BMC Nursing, 20*(1), 1-10.

Lichvar, A. B., Hedges, A., Benedict, N. J., & Donihi, A. C. (2016). Combination of a flipped classroom format and a virtual patient case to enhance active learning in a required therapeutics course. *American Journal of Pharmaceutical Education, 80*(10), 175.

Liu, M. (2017). Flipping for critical analysis: Evaluating the effectiveness of a novel teaching approach in postgraduate law modules. In *EduLearn17 Proceedings* (pp- 6287). Barcelona, Spain: IATED.

Llamas, J. M. C. (2011). Collaboration between faculty members and school counselors: An experience

from a case-based course. *Innovative Higher Education, 36*(3), 177-187.
Lopes, A. P., & Soares, F. (2018). Perception and performance in a flipped Financial Mathematics classroom. *International Journal of Management Education, 16*(1), 105–113.
Lopes, A. P., Soler, M., Caña, R., Cortés, L., Bentabol, M., Bentabol, A., . . . Luna, M. (2019). Gamification in education and active methodologies at higher education. In *EduLearn19 Proceedings* (pp. 1633-1640). Palma, Spain: IATED.
Mareca, M. P., & Bordel, B. (2019). The educative model is changing: Toward a student participative learning framework 3.0—Editing Wikipedia in the higher education. *Universal Access in the Information Society, 18*(3), 689–701.
McLaughlin, J. E., Griffin, L. M., Esserman, D. A., Davidson, C. A., Glatt, D. M., Roth, M. T., . . . Mumper, R. J. (2013). Pharmacy student engagement, performance, and perception in a flipped satellite classroom. *American Journal of Pharmaceutical Education, 77*(9), 196.
Menegaz, JdC., Dias, G. A. R., Trindade, R. F. S., Leal, S. N., & Martins, N. K. A. (2018). Flipped Classroom in teaching nursing management: Experience report. *Escola Anna Nery, 22*(3), 1-7.
Padilla, J., Nascimento, C., & Pereira Guerreiro, M. (2021). Flipped classroom: Views of undergraduate nursing students. In *EduLearn21 Proceedings* (pp. 3712-3717). Valencia, Spain: IATED.
Palomares, A., García, R., & Cebrían, A. (2017). *Integración de herramientas TIC de la Web 2.0 en sistemas de Administración de Cursos (LMS) tipo Moodle*. Barcelona, Spain: Octaedro.
Papalewis, R. (1995). Collaboration between the California State University and the University of California for more extensive teacher training programs. In *6th International Conference of the Society-for-Information-Technology-and-Teacher-Education (SITE 95)* (pp. 844-845). San Antonio, Tx, USA: Assoc. Advancement Comuputing Education.
Parra-González, M. E., López Belmonte, J., Segura-Robles, A., & Fuentes Cabrera, A. (2020). Active and emerging Methodologies for ubiquitous education: Potentials of flipped learning and gamification. *Sustainability, 12*(2), 602.
Pérez-Ramos, A., Rodríguez-Ruiz, M. D., & Bentabol, M. J. (2021). The photogrammetry method and 3D virtualization technology as a learning tool in the flipped classroom at Covid-19 time. In *Proceeding of International, Technology, Education and development Conference-2021 (INTED2021 Conference)* (pp. 6741–6747). Valencia, Spain: IATED.
Peterson, D. J. (2016). The flipped classroom improves student achievement and course satisfaction in a statistics course: A quasi-experimental study. *Teaching of Psychology, 43*(1), 10–15.
Perez-Poch, A. et al. (2019). Cooperative learning and embedded active learning methodologies for improving students' motivation and academic results. *International journal of engineering education, 35*(6), 1851-1858.
Polat, H., & Karabatak, S. (2021). Effect of flipped classroom model on academic achievement, academic satisfaction and general belongingness. *Learning Environments Research*, 1-24.
Portelance, L., & Caron, J. (2016). Collaboration through knowledge sharing between cooperating teachers and university supervisors. *Book Education-A Journal of Educational Research and Practice, 26*(1), 36-51.
Prendes, M. P. (2009). *Plataformas de campus virtual con herramientas de software libre: Análisis comparativo de la situación actual en las universidades españolas*. Retrieved from http://www.um.es/campusvirtuales/informe_final_CVSL_SF.pdf.
Martín, A. P., Martín, D. D., Sanz, J. M., & Martín, E. R. (2014). Experiencias de aplicación de estrategias de gamificación a entornos de aprendizaje universitario. *ReVisión. Revista de Investigación en Docencia Universitaria de la Informática, 7*(2), 76-92.
Rojas-de-Gracia, M. M., & Alarcón-Urbistondo, P. (2021). The Methodological Context in Higher Education. In Handbook of Research on Barriers for Teaching 21st-Century Competencies and the Impact of Digitalization (pp. 15-36). Pennsylvania: IGI Global.
Rotellar, C., & Cain, J. (2016). Research, perspectives, and recommendations on implementing the flipped classroom. *American Journal of Pharmaceutical Education, 80*(2), 34.
Rothman, D. (2016). *A tsunami of learners called Generation Z*. Retrieved from: http://www.mdle.net/Journal/A_Tsunami_of_Learners_Called_Generation_Z.pdf
Sailer, M., & Sailer, M. (2021). Gamification of in-class activities in flipped classroom lectures. *British Journal of Educational Technology, 52*, 75–90.

Sánchez, J. A., Forés, A., & Viccari, J. M. (2011). Colaborar entre docentes para innovar en la enseñanza universitaria. In T. Pagés, A. Cornet, & J. Pardo (Eds.), *Buenas practices docents en la universidad* (pp. 33-42). Barcelona, Spain: Octaedro e ICE-UB.

Santos, M. A., Sotelino, A., Jover, G., Naval, C., Álvarez, J. L., Vázquez, V. (2017). Diseño y validación de un cuestionario sobre práctica docente y actitud del profesorado universitario hacia la innovación (CUPAIN). *Educación XXI, 20*(2), 39-71.

Senties Santos, M. E., Pérez Prieto, S., & Fernández Arrazola, Z. L. (2021). Inverted classroom, the act that changes the roles in the teaching-learning process; and whose staging accelerated the covid. In *Proceeding of International, Technology, Education and development Conference-2021 (INTED2021 Conference)* (pp. 11168–11173). Valencia, Spain: IATED.

Setren, E., Greenberg, K., Moore, O., & Yankovich, M. (2021). Effects of Flipped Classroom Instruction: Evidence from a Randomized Trial. Education Finance and Policy, 16(3), 363-387.

Shih, W. L., & Tsai, C. Y. (2017). Students' perception of a flipped classroom approach to facilitating online project-based learning in marketing research courses. *Australasian Journal of Educational Technology, 33*(5).

Sommer, M., & Ritzhaupt, A. D. (2018). Impact of the flipped classroom on learner achievement and satisfaction in an undergraduate technology literacy course. *Journal of Information Technology Education: Research, 17*(1), 159–182.

Snowdon, D., Churcill, E. F., & Munro, A. J. (2001). Collaborative virtual environtments: Digital places and spaces for CSCW: An introduction. In E. F. Churchill, D. Snowdon, & A. J. Munro (Eds.), *Collaborative virtual environments. Digital places and spaces for interaction* (pp. 3-16). London, UK: Springer.

Stoddard, K., Kewitt, M., & Danforth, S. (1997). The bridge project: Bridging the gap between university and schools. *Journal of Learning Disabilities, 30*(4), 408-413.

Styers, M. L., Van Zandt, P. A., & Hayden, K. L. (2018). Active learning in flipped life science courses promotes development of critical thinking skills. CBE Life Sciences Education, 17(3), ar39.

Suanse, K., & Yuenyong, C. (2021). Development of the analytic geometry flipped classroom teaching model through Google Classroom. In *Journal of Physics: Conference Series* (vol. 1835(1)). London, UK: IOP Publishing.

Teo, T. W., Tan, K. C. D., Yan, Y. K., Teo, Y. C., & Yeo, L. W. (2014). How flip teaching supports undergraduate chemistry laboratory learning. *Chemistry Education Research and Practice, 15*(4), 550–567.

Toriz, E. (2019). Learning based on flipped classroomwith just-in-time teaching, Unity3D, gamification and educational spaces. *International Journal on Interactive Desing and Manufacturing, 13*(3), 1159–1173.

Van Wyk, M. M. (2019). Flipping the economics class in a teacher Education Course. Technology, Knowledge and Learning, 24(3), 373–399.

Varannai, I., Sasvári, P. L., & Urbanovics, A. (2017). The use of gamification in higher education: an empirical study. *International Journal of Advanced Computer Science and Applications, 8*(10), 1-6.

Vergara, D., Paredes-Velasco, M., Chivite, C., & Fernández-Arias, P. (2020). The challenge of increasing the effectiveness of learning by using active methodologies. *Sustainability, 12*(20), 8702.

White, P. J., Naidu, S., Yuriev, E., Short, J. L., McLaughlin, J. E., & Larson, I. C. (2017). Student engagement with a flipped classroom teaching design affects pharmacology examination performance in a manner dependent on question type. *American Journal of Pharmaceutical Education, 81*(9), 5931.

Xiu, Y., Moore, M. E., Thompson, P., & French, D. P. (2019). Student perceptions of lecture-capture video to facilitate learning in a flipped classroom. *TechTrends, 63*(4), 369-375.

Zamora-Polo, F., Corrales-Serrano, M., Sánchez-Martín, J., & Espejo-Antúnez, L. (2019). Nonscientific university students training in general science using an active-learning merged pedagogy: Gamification in a flipped classroom. *Education Sciences, 9*(4), 297.

Zeman, T., & Hrad, J. (2014). Benefits of Collaboration between a university and a vocational college. In *2014 25th Annual Conference EAEEIE* (pp. 37-40). Cesme, Turkey: IEEE.