E-Learning Experience with Flipped Classroom Quizzes Using Kahoot, Moodle and Google Forms: A Comparative Study

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In recent years, the use of technology is gaining weight in higher education. Today's students are digital natives and e-Learning is common for them. Furthermore, they find traditional teaching methods tedious. In order to improve their motivation, different strategies are used, for instance, Flipped Classroom instructional model or gamification. One of the fundamental steps of the Flipped Classroom approach is the application of quizzes to assess the knowledge acquired by the students in the theoretical activity that they develop at home. Tools such as Google forms, Moodle or Kahoot can be used for these quizzes. Based on our experience of introducing the Flipped Classroom approach in the computer science degree in 11 subjects, we show the advantages and disadvantages of each of analyzed tools. Class quizzes results show that the theoretical subjects obtained a higher success rate and also in the subjects in which Kahoot was used, the results were higher. In addition, students rated better the Flipped Classroom surveys in which Kahoot was used. Finally, the application of Flipped Classroom approach improved the students' assessment of those subjects when compared to the previous course.

CCS Concepts: • **Information systems** → **World Wide Web**.

Additional Key Words and Phrases: Flipped Classroom, e-Learning, Kahoot, Google Forms, Moodle

1 INTRODUCTION

It is undeniable that digitalization has brought great changes in the way things are done in society. The habits and ways of doing things in society, and young people in particular, have changed a lot in the last decades. The university community is no exception and has also had to consider these changes in the way it motivates, works with and evaluates the future people who will have to design and develop society. This has meant reflecting on and making changes, especially with regard to technological and pedagogical innovations.

New technologies allow teachers to communicate and collaborate with students in a different way during the learning process. But in addition to the use of technologies, it is necessary to analyse the methodologies associated with them

and the workspace that each of them provides during the learning process [9].

The teaching community, aware of the opportunities and challenges posed by the use of technology, is immersed in a progressive transformation to incorporate technology into education, but always bearing in mind that such use must be rational and beneficial to the learning process [26]. The e-Learning is the main term that refers the use of technology in education. "E-Learning refers to the use of Internet technologies to deliver a broad array of solutions that enhance knowledge and performance" [21].

Experts in neuroscience have no doubt that student motivation is a key factor in obtaining satisfactory results in the learning process [13]. Therefore, new pedagogical proposals point to constructivist learning. This learning approach is based on the principle that the students are active participants of their learning process. Within this learning paradigm, the students construct knowledge based on experiences, integrating new information with their prior language [27]. One of the most widely applied constructivist learning approaches in education is the Flipped Classroom instructional model [1]. The key of Flipped Classroom model consists of students preparing lecture contents at home, before the actual lecture starts in class. Afterwards, with the lecturer as a guide, classroom time is used for additional added-value activities where students deepen and complement the content previously acquired [5]. According to recent studies and Flipped Classroom implementations, this approach benefits students in several ways: (1) it facilitates active learning, (2) it enables collaborative teamwork, (3) it stimulates self-learning and (4) it enables to learn advanced language [4, 22]. One of the key points of the Flipped Classroom model is the assessment and use of new tools that help in progressive learning over time. There are tools known as "Web-based student response systems (SRSs)" that help motivating students [14]. Additionally, they are utilized to check the students' knowledge about the lecture before starting the class activity. Not all of them have the same objective, nor do they achieve the same effect.

Considering the benefits of Flipped Classroom supported by SRSs, in this work we introduce a process to implement the Flipped Classroom approach. This approach has been implemented in the computer science degree of our university. 6 subjects of the first semester and 5 of the second semester implemented this approach the first year. In this work we have chosen some of these SRSs, we have also defined analysis criteria and we have carried out an analysis with the aim of identifying which of the SRS tools is most effective in specific contexts. The study has been based on real use cases carried out in a computer engineering degree where different subjects have made use of the different tools. Specifically, 3 tools have been chosen and an analysis has been carried out in order to make the most objective comparison possible based on different criteria. These tools were Kahoot, Google Forms and Moodle.

The final objective is to identify the appropriate context for each of the tools and to know how to get the best out of each of them.

Section 2 presents the background or basic characteristics of each of the SRSs considered in the study. Section 3 explains the advantages and disadvantages of each tool. Section 4 presents the evaluation and its results based on different questionnaires performed in class sessions and at the end of the semester and section 5 concludes the paper.

2 BACKGROUND

2.1 Google forms

Google Forms[1] is an integrated web-based application provided by Google Inc[2]. Google Forms is widely used in education to evaluate students' learning [18]. This application enables the creation of online surveys and questionnaires while collaborating with other users in real-time. The questions of the survey can be defined in a survey-like format

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[1]http://forms.google.com
[2]https://docs.google.com/forms/

through a user-friendly web interface. Google forms provides different question types to collect the answers of the survey and enables to configure the visual style of the questionnaire.

The students have to log in online with their Google mail account to use Google Forms and complete the survey. In this way, the survey results are stored along with the emails of the students who have completed it. The answers of the survey are automatically compiled into a spreadsheet, which can be downloaded into a Microsoft Excel file to be analysed [24].

Google Forms has been used in previous Flipped Classroom experiences [11], [3]. According to the students feedback and the survey results of these Flipped Classroom experiences, the students understood the concepts easily. In addition, they obtained better results in academics compared to students that followed a traditional learning approach.

2.2 Moodle

Moodle[3] is highly customizable and widely used free open source Learning Platform or course management platform. Moodle is used by hundreds of thousands of organisations in primary education, higher education and even by companies to manage their training courses.

In Moodle it is possible to add courses in which some people act as teachers and others as students. Moodle provides teachers and students with numerous tools than can be used as learning materials, such as presentations, books, HTML pages or even videos. In addition, it also allows the creation of assignments, so that students can upload the work to be done. In addition, quizzes can be also created to evaluate or put into practice the knowledge they have acquired during the course. The results of the quizzes can be analysed in the Moodle itself and can be also exported to different formats for further analysis.

Moodle has been widely used as a tool for Flipped Classroom approach [6], [7], [8]. The results of these experiences show that both students' knowledge and academic results improve with respect to traditional teaching.

2.3 Kahoot

Kahoot[4] is a game-based learning platform wide used in education. Kahoot main objective is to increase engagement, motivation, enjoyment, and concentration to improve learning performance and classroom dynamics. This application allows you to create surveys, questionnaires and discussions, obtaining feedback from students in real time. The lecturer creates the questions and determines the number of answers and the time the student has to answer respond. The questions are projected in the classroom and the students, through their computers, tablets or mobiles, answer questions adjusting to the marked time. Each question shows the respective winner and points are accumulated to provide a final ranking, as if it was a competition. The questionnaires are easy to create and allow the introduction of images, expanding the type of questions that can be asked to the students. Its interface is very simple, which makes it very easy to use.

Alf Inge Wang is the creator of Kahoot and in his researches, he affirms that "the results showed many positive effects for the gamified approach, including improved class attendance, less late arrivals to class, higher downloads of course material, improved classroom dynamics, and higher final grade" [25].

Kahoot is a tool designed primarily for children's education, but it has been used in different university contexts [12] [17] [10] [16]. The results of these experiences reveal that the use of Kahoot improved students engagement, motivation and learning experience.

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[3]https://moodle.org/?lang=en
[4]https://kahoot.com/

3 TOOL ANALYSIS

In our e-Learning experience, the students were given a questionnaire to check if they had correctly understood the concepts they studied at home.

For this purpose, Google Forms, Moodle and Kahoot tools were used. In the following subsections we will analyze the advantages and disadvantages of each of these tools for conducting pre-class quizzes when using the Flipped Classroom instructional model. Table 1 summarizes the characteristics of these tools. These characteristics have been extracted from the following reference [2].

3.1 Google Forms

The main reason for choosing Google Forms tool for our Flipped Classroom experience is that it provides an intuitive interface to create questionnaires via web forms. Its ease to create and manage surveys saves time when creating questionnaires. Therefore, Google Forms is a good option to create simple forms with respect to other alternatives [24]. Another advantage of Google Forms among other survey tools is that it is completely free to use and it does not require any specific access profile. Teachers can create an unlimited number of surveys and the created questionnaires can be shared to an unlimited number of students.

Google Forms provides a wide variety of free options when configuring the questionnaire and capturing the data from answers. It supports the following question types: Short answer, Paragraph text, Multiple choice, Checkboxes, Choose from a list, Scale, Grid, Date and Time [15]. Unlike other survey tools such as Kahoot, these question types are freely available in Google Forms. On the downside, Google Forms does not enable to configure other advanced aspects of the questionnaire such as setting the questionnaire deadline, setting time limit of the answers, allowing students to know immediately if the answer is correct or adding mathematical formulas to question and answer text. Google Forms neither does it enable students to compare their results. Hence, it is not suitable for gamification.

With regard to the visual aspect, Google Forms enables to configure the style of the questionnaire. In particular, it enables to define the background colour of the survey and the font of the text. The teacher can also include images and videos in each question. The images can be also included as a header for the questionnaire. In addition, the questionnaires created with Google Forms can be embedded in other academic platforms such as Moodle and in any web environment (i.e., WordPress). Free training webinars are available to learn how to use Google Forms and integrate it with other platforms.

Finally, Google Forms enables an easy management of the survey results. Once the questionnaire is completed, Google Forms stores automatically the results along with the emails of the students. The results of the survey are compiled into a spreadsheet that can be opened with Microsoft Excel. The data is automatically recorded in an analysable format to enable a graphical representation descriptive statics about the survey. The results and statistics can be easy imported into another format such as MS Word [24]. However, unlike other survey tools such as Moodle, Google Forms does not report information about class preparedness and class participation.

3.2 Moodle

Typically, Moodle is used to view the videos hosted on YouTube (privately) and to carry out the post-video quizzes. Thanks to this, it possible to have in one single place all the necessary material for the subject including the Flipped Classroom experience resources. Other reasons for choosing the Moodle platform over others might be its integration with the university's academic platform and the unambiguous identification of students. These factors are important,

when the quiz scores are taken into account for the final grade of the subject.

The creation of the quizzes is quite "cumbersome", the interface is rather unintuitive and the process is slow. However, during the creation process, the questions are collected in a course question bank, thus facilitating the reuse of the questions in other quizzes or tests. This may be a very important feature in those subjects, where the theoretical weight can be significant.

In addition to the typical questions (open, closed, true, false) it is also possible to create drag & drop questions in which a concept should be placed in the right position, like for example, place city name on its country in a map. It is also possible to add complex mathematical formulas to both the question and answer texts thanks to its LATEX compatibility. And not just that, answers can also be calculated on the basis of mathematical formulae, allowing numerous variants of the same question to be randomly generated at the moment the question is shown to the student.

Although with Moodle it is possible to set a very specific period to do the quiz, each student responds at his or her own pace and therefore some may finish sooner than others. For this reason, it is necessary to wait until all students have finished the quiz so that the questions that have raised particular problems can be discussed afterwards. Besides not allowing everyone to answer the same question at the same time, neither does it allow students to compare themselves with other students. Therefore, Moodle is not the most suitable tool for gamification.

3.3   Kahoot

Kahoot is a tool designed primarily for children's education, but it has been used in different university contexts [12] [17] [10] [16]. Kahoot has different plans depending on the workplace (school, university, business, etc.). For example, if we consider only the free versions, in schools, it can be used with up to 50 students, but in universities it can only be used with up to 10 users. This aspect can be a handicap to use Kahoot among university students for free. Paid licenses allow a larger number of users and allow different types of questionnaires. The free version includes multiple-choice questions and true and false questions. The paid version includes drag and drop questions, text answers, etc. Anyway, Kahoot has been frequently used for Flipped Classroom questionnaires at the beginning of the class [23], [20]. On the downside, it cannot be integrated with educational platforms such as Moodle, nor does it allow students to be uniquely identified. Students must enter their name and sometimes some prefer to enter funny names. Unfortunately, the number of characters in questions and answers is limited, although in most cases it is sufficient. Finally, Kahoot gives you a brief report on the hits and misses on each question but it does not provide information about class participation until the quiz is finished.

One of the main advantages of Kahoot is gamification. There are a lot of studies that demonstrate the advantages of digital games in learning, not only for transversal skills like communication, collaboration, fine motor skill, to name but a few but also for specific skills in particular knowledge domains [19]. Another great advantage is the integration of the questions in presentation tools that allow asking questions during the presentation of the syllabus to keep the attention of the students. In our particular case, the quizzes are done at the beginning of class. Compared to Moodle and Google Forms, Kahoot allows students to answer the same question at the same time. Once the time of the question is over (which allows that if a student does not answer in the time provided, we can see the rest of the answers), the teacher can see the number of correct and incorrect answers. This allows that if the number of incorrect answers is high, the teacher can give an explanation and deepen in key aspects of the new topic that have not been clear through the previous viewing of the video.

Table 1. Comparing Google Forms, Moodle and Kahoot characteristics

Ref	Google Forms	Moodle	Kahoot
Unlimited number of users (free license)	✓	✓	✗
Provides integration with academic platforms (i.e., Moodle)	✓	✓	✗
Provides SSO/LDAP integration to identify students unequivocally	✓	✓	✗
Includes on-premise mode	✗	✓	✗
Includes cloud mode	✓	✓	✓
Allows to record attendance	✓	✓	✓
Supports images	✓	✓	✓
Supports Latex	✗	✓	✗
Allows to host multiple quizzes simultaneously	✓	✓	✓
Allows to set a deadline to the questionnaire	✗	✓	✓
Enables a preview of the questionnaire before activating it	✓	✓	✓
Allows to immediately know if your answer is correct	✗	✓	✓
Unlimited number of characters on questions	✓	✓	✗
Unlimited number of characters on answers	✓	✓	✗
Allows to configure visual aspects of the quiz (i.e., font, color)	✓	✓	✓
Possibility to randomize the number and order of the questions	✓	✓	✓
Possibility to create drag-and-drop exercises, images or text	✗	✓	✓
Possibility to create mathematical exercises	✗	✓	✗
Allows to set an answer time per question	✗	✗	✓
Allows to set an answer time per questionnaire	✗	✓	✗
Possibility for students to answer the same question simultaneously	✗	✗	✓
Allows explanation after question	✓	✓	✓
Allows to know how many have failed each question	✓	✓	✓
Allows to know the answers (of each student) individually	✓	✓	✓
Supports different user types	✗	✓	✓
Supports different types of answers (i.e., open-ended, multiple choice)	✓	✓	✓
Enables to export and analyse the survey results	✓	✓	✓
Supports integration with presentation tools (i.e., Powerpoint, Slides)	✗	✗	✓
Includes gamification	✗	✗	✓

4 EVALUATION

This section provides an evaluation three e-Learning tools (Google Forms, Moodle and Kahoot) in the subjects included in our Flipped Classroom experience. First, we describe how the Flipped Classroom methodology was applied. Then, we analyze the results of the quizzes employed to check the students' knowledge about the lectures. We next provide the students' opinion about each subject and quiz tool based on a survey specifically conducted for our Flipped Classroom experience. Finally, we analyze the results of the students' survey conducted by the institution for quality assurance in the teaching activity, comparing the results of each subject for 2019-2020 and 2020-2021 courses. These are our research questions:

- RQ1: Is there any difference between the results of the quizzes in relation to the tool and the type of subject?
- RQ2: Is there any relationship between the students' favorite tool and the number of correct answers in the quizzes?
- RQ3: Has the whole experience made the assessment of the subjects better than the previous year?

4.1 Applied Flipped Classroom Methodology

In our Flipped Classroom experience, the students watched videos where the teacher explained the contents of the next lecture. The videos used in each subject are 10-15 minutes long and each one explains a series of basic concepts of the subject through examples. After watching the videos and before starting the next class, the students were given a questionnaire to check if they had correctly understood the concepts explained in the videos.

In total, 11 subjects have been involved in our Flipped Classroom experience. The professors teaching these subjects include engineers and researchers in the fields of information systems, cyber-security, data analysis and electronics. The subjects include both theoretical subjects and subjects with a more practical focus.

The theoretical subjects include Software Analysis and Design, Software Engineering, Physics, Analog Electronics, Project Management, Security and Information Systems. Analysis and Software Design and Software Engineering deal with good practice in the development of software systems. In Physics, the students learn basic concepts about electronic physics, electrostatics, electromagnetism and their application to solving engineering problems. Analog Electronics deals with the part of electronics associated with analogue signal processing. Project Management teaches how to plan, conceive, deploy and manage Information Technology (IT) projects, services and systems.

In Security subject, the students learn to determine the requirements of the organization information and communication systems taking into account aspects of security and compliance with current regulations and legislation. Finally, Information Systems deals with integrating Information and Communications Technology solutions and business processes to meet the information needs of organizations.

On the other hand, the practical subjects include Basic Programming, Advanced Programming, Databases and Programmable Logic Systems. Basic and Advanced Programming deal with developing software programs. In the Databases subject, the students acquire knowledge about the characteristics, functionalities and structure of databases. Finally, Programmable Logic Systems teaches how to design and build digital systems, including computers, microprocessor-based systems and communications systems.

Table 2 shows detailed information about these subjects. They are ordered by the academic year and semester in which they are taught. The table also specifies the number of the students enrolled and the duration of the Flipped Classroom experience within each subject.

4.2 RQ1: Is there any difference between the results of the quizzes in relation to the tool and the type of subject?

The students filled in a set of quizzes in each subject to evaluate their comprehension about the lesson taught in the videos they watched before the lessons. Google Forms, Moodle and Kahoot where applied to create the quizzes, which contained both multiple-choice and open-ended questions. The duration of the quizzes was about 10-15 minutes.

The quizzes were displayed differently depending on the type of tool used. The quizzes made in Kahoot were displayed on the classroom projector and students answered the questions from their mobile phone or computers. While the quizzes made with Google Forms or Moodle, students accessed the quizzes from their computer and filled it at their own pace usually with an overall time limit.

Table 3 (columns 1-4) shows the results of the video quizzes. The table includes the survey tool, the subject type, the number of quizzes conducted and the average percentage of correct answers obtained by students in the video quizzes for each subject. The results are grouped by the survey tool applied in each subject and the subject type (theoretical or practical). It is worth mentioning that among all subjects, 95% of the questionnaires were answered.

Table 2. Subject description

Academic Year	Semester	Subject	Subject Type	No. of Students	Duration
1	1	Basic Programming	Practical	58	12 weeks
		Physics	Theoretical	40	4 weeks
	2	Analog Electronics	Theoretical	25	3 weeks
2	1	Advanced Programming	Practical	53	12 weeks
		Programmable Logic Systems	Practical	23	7 weeks
	2	Databases	Practical	38	5 weeks
		Software Analysis and Design	Theoretical	34	4 weeks
3	1	Project Management	Theoretical	30	3 weeks
		Software Engineering	Theoretical	32	4 weeks
	2	Information Systems	Theoretical	30	6 weeks
		Security	Theoretical	29	10 weeks

Table 3. Quiz and Flipped Classroom survey results

Survey Tool	Subject Type	Subject	No. of quizzes	% of correct quiz answers	FC Survey
Google Forms	Theoretical	Software Analysis and Design	4	87%	3.31
	Practical	Advanced Programming	9	39%	2.81
		Databases	9	66%	3.90
Moodle	Theoretical	Physics	5	58%	3.33
		Information Systems	12	64%	3.00
		Project Management	5	34%	2.13
	Practical	Programmable Logic Systems	6	65%	3.30
Kahoot	Theoretical	Software Engineering	7	71%	3.44
		Analog Electronics	4	56%	2.97
		Security	10	70%	3.87
	Practical	Basic Programming	8	58%	3.68

The results evidence that the percentage of correct answers is higher in theoretical subject types than practical ones where Google Forms and Kahoot were applied. In the case of Moodle, excepting the Project Management subject, there is not great difference between theoretical and practical subject results.

With regard to the quiz tools, results have been slightly better in subjects where Kahoot was used, since there is no subject with a percentage of correct answers below 50%. Otherwise, with the exception of a couple of subjects (Software Analysis and Design, Advanced Programming, Project Management), there have not been great differences in the quizzes results. In fact, taking the values in Table 3 fourth column as a reference, the average percentage of correct answers in the subjects for each of the quiz tools was as follows: 64% in Google Forms, 55.2% in Moodle and 63.7% in Kahoot.

Considering these results, there are no major differences in the percentage of correct answers depending on the number

of quizzes done or the quiz tool used to perform the questionnaire. The only notable difference between the quiz tools is that in Kahoot there have been no subjects with excessively low percentage of correct answers. Therefore, we can state that the fact of using one survey tool or another does not have a big impact on the results of the subject quizzes. We can also state that results have been slightly better in theoretical subjects, irrespective of the tools used.

4.3   RQ2: Is there any relationship between the students' favorite tool and the number of correct answers in the quizzes?

At the end of each semester, a survey was carried out to find out the acceptance of the tools used to implement the Flipped Classroom instructional model in each subject. The students were asked to evaluate on a Likert scale [18] from 1 to 5 (1) how understandable the videos were, (2) how much it facilitated the viewing of videos to understand the new concepts of the subject, (3) how much the quizzes helped them to deepen their theoretical knowledge of each subject and (4) the survey tools used to develop the quizzes. Table 3 fifth column shows the results of the selected question of the Flipped Classroom survey grouped by tool, type of subject and subject.

Analysing the overall results of each tool, Kahoot was the best rated by the students with an average score of 3.49, slightly better than Forms (3.28) or Moodle (3). Segregating the data, Kahoot is also the preferred tool in the practical subjects (3.68) while Moodle and Forms obtain practically the same result, 3.29 and 3.28 respectively. Regarding the theoretical subjects, Kahoot is again the tool with the best rating by the students (3.39), although it is closely followed by Forms (3.31). In this case Moodle was the worst rated with a 2.87 score. All tools except Forms, which obtained very similar results, obtained better results in the practical classes: Kahoot +0.29, Moodle +0.43, Forms -0.03, being the overall rating of tools used in the theoretical and practical subjects 3.16 and 3.39 respectively.

Regarding the feedback, not many comments were received regarding the tools used, but the few that were received were positive regarding the use of Kahoot. Kahoot seems to motivate more students because of its gamification component. But not only gamification has been taken into account by students. Another feature of Kahoot that was highly valued by the students was being able to see "live" which questions were most frequently missed by the class. This helped them to focus their attention when the teacher was providing detailed explanations and answering students' questions in order to clarify these concepts.

With the obtained results, although there are no major differences in the students' evaluations regarding the quiz tools, it seems to indicate that Kahoot is the most preferred tool by students. On the one hand, it is the tool that has obtained the highest rating in both theoretical and practical subjects. On the other hand, it was the only tool that received written feedback from students, always highlighting positive qualities. Analyzing the fifth and sixth columns of table 3, the subjects that have obtained a hit rate in the class quizzes lower than 40%, have obtained the worst evaluation by the students in the experience survey. On the other hand, when the hit rate was higher than 55%, there is no significant difference between the students' assessment. This shows that very complicated quizzes are not appreciated by the students and that the hit rate must be higher than 50% for the students to value the experience satisfactorily.

4.4   RQ3: Has the whole experience made the assessment of the subjects better than the previous year?

At the end of each semester, the institution conducts a students survey to evaluate the subjects. This survey is one of the activities of the university's quality assurance framework and follows the guidelines provided by the university quality program of the national agency. Each student answers the survey evaluating different aspects such as the teacher, course organization, materials, resources and an overall grade. Note that the overall assessment of the subjects is based on Likert scale from 1 to 5 [28]. The survey is carried out using a tool provided by the institution itself. This study

Table 4. Students' survey results for the 2019-2020 and 2020-2021 courses.

Subject	Overall grade		Diff
	19-20	20-21	
Basic Programming	4.440	4.325	-2%
Physics	4.320	4.190	-3%
Advanced Programming	4.415	4.175	-5%
Databases	4.330	4.585	5%
Security	4.370	4.290	-2%
Analog Electronics	2.950	3.145	4%
Software Analysis and Design	3.620	3.525	-2%
Programmable logic Systems	3.240	4.195	19%
Project Management	3.940	3.860	-2%
Information Systems	3.200	3.390	4%
Software Engineering	3.340	3.570	5%

employs the results of the overall assessment of the students survey for the 2019-2020 and 2020-2021 academic years. The results of these two years have been selected to compare the results of the courses in which the Flipped Classroom approach was used (i.e., course 2020-2021 in which the comparative study of the tools is focused) with the previous course (i.e., course 2019-2020 in which the Flipped Classroom approach was not used). Table 4 presents students' survey results for the previously indicated courses. For each of the subjects 3 columns of data are provided. The first two columns present the average result of the students' assessment of the subject for the 2019-2020 and 2020-2021 courses respectively. The third column shows for each subject the percentage variation.

The rows of the table are divided into two sets. The first 5 records show those subjects that in the 2019-2020 academic year obtained a grade higher than 4 and therefore are subjects well valued by the student body. The second set consists of 6 subjects that in the academic year 2019-2020 obtained a rating lower than 4 and therefore are not as well valued by the students as those in the first set. From the results obtained, it can be concluded that overall, the subjects in the first set have not improved the students' perception of the subjects. Specifically, all the subjects, with the exception of Databases, have worsened by an average of 1%. However, in the second set of subjects the students' perception has improved by an average of 5%. We therefore consider that those subjects whose students' assessment is perceived as improvable, can benefit from using this Flipped Classroom approach.

5 CONCLUSIONS

In this paper we present a comparison of three tools in their application for e-Learning within the Flipped Classroom instructional method. The purpose of the paper is to provide a guide to the practitioners to assist in the selection and use of quiz tools. For this purpose, we conducted a study in 11 subjects of the computer science degree of the university's engineering faculty. For the evaluation we used (i) the results of the quizzes used in class to assess the level of understanding of the subject, (ii) a specific question to evaluate the quizzes in the survey conducted in the evaluation of the Flipped Classroom instructional method, (iii) the comparison of the results of the survey that at institutional level is completed to assess the overall perception of students regarding the subject of the courses 2019-2020 and 2020-2021. From the obtained results we share with the community the following conclusions regarding the tools. One of the most relevant features of Kahoot is gamification. Students always want to play with Kahoot and they are motivated and attentive to the questions to beat classmates. Students analyze the question and if they fail, they pay attention to

know the reason for their failure. This reinforces the learning of certain important aspects with the use of this tool. Google Forms provides an intuitive interface that saves time when creating questionnaires. It also enables an easy and automatic management of the survey results. Therefore, Google Forms is a good option to create simple questionnaires that do not require advanced configuration (i.e., setting a questionnaire deadline, setting an answer time, inclusion of mathematical formulas). Moodle can be a useful tool to employ in subjects that require complex mathematical formulas, such as physics or mathematics. In addition, Moodle might be particularly interesting when the type of survey goes beyond a closed-ended quiz.

Overall, the study allows us to conclude that those subjects that have used more complex questionnaires, with worse results from the students, receive a worse overall assessment. In addition, the subjects that have room for improvement in the student surveys are the ones that benefit the most from the implementation of the Flipped Classroom method. For the future, our goal is to add new subjects to our Flipped Classroom experience next course. This will lead to us be able to give more specific questionnaires about the class quizzes to the students. Moreover, we consider it interesting to identify other tools for conducting quizzes that will allow us to unify the benefits of the tools studied.

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