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Knowledge Assessment Using A Games-Based Learning Platform

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Abstract

This research presents an analysis of the use of the Kahoot platform as an evaluation system for programming students, using two groups, the first is evaluated in a traditional way through a written exam and serves as a control group, and the test group through the Kahoot platform, where they can also observe their grade at the end of the test, obtaining statistics of which is the best, which becomes a competition for them. The population was 58 students, where the test group obtained a superior performance of 15.24% over the control group, demonstrating that the students who used Kahoot feel more motivated, due to the process that generates a game, where they compete with each other, and also to the methodology of the platform that allows repeating the concepts seen in the classes.

Keywords: programming; Kahoot; evaluation; LMS; conditional structures.

1. Introduction

The tools for evaluating students are focusing on using devices such as computers, cell phones and tablets, through platforms that offer tests, crossword puzzles, multiple choice, games or complete the answers with text, among others; each platform has statistics, online rating and feedback to the student, and evaluations can be performed from anywhere in the world, including outside the university campus; these systems are called Learning Management Systems (LMS).

Among the most important LMS we can mention Blackboard, which is used in different institutions, due to its number of tools for the teacher and the student. Researchers such as Charles Darko (2021) have found that the longer a student remains using the material of the Blackboard platform, their academic performance increases, due to the same model of repetition or similar to the use of flashcards (Dizon & Tang, 2017; Elisa & Tuti, 2020), being the academic platform of the institution the advantage of it cannot be measured, but it could be perceived that it was preferred for its good presentation design. A research where two LMS systems such as Blackboard and Brightspace are used, showed that students preferred Brightspace, by analyzing 513 students at Umm Al-Qura University (Yamani et al., 2022).

While in the research comparing Blackboard vs Canvas, they found no significant difference between the usage and satisfaction of both systems (Gumasing et al., 2022).

Canvas is another platform widely used in the academic environment, where research has shown that using it improves academic performance over students who use it less (Nalyvaiko & Vakulenko, 2021; Vargas Manchego, 2021), even in subjects where courses can be complex to design, such as mathematics (Vilchez et al., 2022).

Moodle is one of the most important platforms, due to the number of institutions and students worldwide that use it, the possibility for teachers to create their courses, design evaluations and monitor students, makes it well received, and it is also well accepted by students. The evaluation possibilities range from forums, questionnaires, assignments, wikis and others, according to Vaganova (2020) the tools preferred by most teachers are questionnaires and wikis with more than 80% of acceptance. Moodle is also used to measure the level of knowledge among teachers, a research conducted by Yüksel (2022) showed that by using two groups of teachers with 44 for control who continued using the traditional method and 43 experimental using Moodle, could be evaluated at the beginning in a traditional way concluding that no significant differences were found between the two, then at the beginning and end of the course it could be shown that at the end the experimental group outperformed the experimental group.

In the COVID-19 pandemic became more latent the needs for online platforms that could be used to organize distance learning, from there the experiences were significant, from language teaching (Grigoryeva et al., 2021), to consultations and courses for medical analysis (Fiza & Sinha, 2022), physiology (Lima et al., 2020), information systems or augmented reality (Aryal & Balan, 2022; Muñoz-Hernandez et al., 2020; Parada et al., 2017), among others; they were focused their efforts in keeping the platform updated for information exchange. The study conducted in College of Engineering, University of Duhok (Rasool & Dawood, 2021), determines the activities to organize the modules which included: creation of the database, organization of the lesson, evaluating and uploading files for students, using workshops, users participating in synchronous conversations, where they could encounter disadvantages due to internet access or lack of adequate courses for the management of the platform, ending up using it to conduct questionnaires or as a communication system with students, if the appropriate corrections are not made.

In Latin America, LMS platforms were being implemented, and their implementation had to be accelerated since 2020 due to the effect of the pandemic. Moodle was used as a means of learning, highlighting the collaborative work, the possibility of designing more innovative activities, but also describing its limitations, such as loss of motivation due to not knowing how to use the platform, exhaustion due to the number of hours in front of the computer because of excessive reading and work, and connectivity problems (Rade et al., 2021). Adding more advantages are the review of evaluations without physical presence or automatically, permanent communication and feedback that saves time by individualizing the attention to each student (Bailón & Loor, 2021).

The Universidad Francisco de Paula Santander Ocaña (UFPSO), has the Moodle platform and most of its subjects digitized on the platform (UFPSO, 2022), each course must be comprised with a welcome module where a video is designed to explain what the course is about, with a duration of less than 2 minutes; a module for the microcurricula and the course planner; a pre-saber test; a content module where all the units to be taught go; a communications area and another for activities. However, innovation is always important, because it can increase the motivation of students, although it is true that all the tools that Moodle brings are adequate, they can also incorporate competition platforms, where it is allowed to use mobile devices and at the same time compete in being the best, thus increasing the level of student interest. Some investigations using tools with games have been developed in the area of programming at the university but without being worth as a main grade, where it has been observed that some students are not stimulated in the presentation due to the minimum percentage that it has in the value of the grade of the subject (Castrillon et al., 2021a, 2021b).

Kahoot is used by almost 50% of teachers in the United States (Haywood, 2021), its eye-catching design, the possibility to compete individually or in groups, and the statistics that the teacher can find from student evaluations, make it a very strong platform. The way students perceive the possibility of being evaluated, while being able to compete with their peers, increases their motivation, for the simple reason of not being exposed. Although Kahoot may have some disadvantages such as high subscription cost, limited customization, stability, among others; it is still a potential tool for teachers and students. Among its advantages are that it can help students' confidence (Atherton, 2018), increase learning and knowledge retention (Elkhamisy & Wassef, 2021), the way of making games is very relevant and students prefer to use Kahoot instead of other platforms (Bicen & Kocakoyun, 2017).
Esta investigación tiene el objetivo de medir el rendimiento académico del primer examen parcial de la asignatura de Fundamentos de programación en la UFPSO, en la Facultad de Ingeniería, utilizando un grupo de control y uno de prueba, de esta manera se podrá conocer si una herramienta de evaluación mediante competencias puede elevar el rendimiento en los estudiantes de programación.

2. Method

The total population was 58 participants, divided into 2 groups, a control group with a sample of 30 students and they are evaluated in the traditional way and a test group with a sample of 28 students who use the Kahoot platform for their evaluation, where students become part of a game or contest as participants, creating a different role in their evaluation. They all have to answer 10 technical knowledge questions obtained randomly, which are basic to know if they understood the syntactic, logical and execution errors, in order to propose a solution to a problem. The time from the beginning of the course to the test was 45 days, the test group was given 3 tests in that period to familiarize them with the platform.
The database consists of 60 questions, which are randomly selected, the questions range from methodology, parts of an algorithm and conditional structures, and with the possibility of multiple choice, true or false answers. Each question is analyzed by two characteristics, which are correctness and time, in Table 1, you can know the questions asked.

Table 1. Random questions asked to competitors.

Number	Question	Time (seconds)
Q1	Select the steps found in a program's life cycle	30
Q2	To calculate the remainder of a division between 8 and 3, and store it in the variable H, write how?	60
Q3	When adding 12 + 12 the result is?	60
Q4	Type in which lines is the error in the following program?	90
Q5	Does the Finalgorithm instruction end with a semicolon?	30
Q6	Would the number of stars be a data type?	30
Q7	The instruction M=8*4+2; has ident after it?	30
Q8	A variable is composed of?	60
Q9	The arithmetic operators are?	60
Q10	Having A=2; B=8; C=3. And evaluating the condition A<>B and A<=C will result in a value?	60

According to the time spent in answering and the correct answers, a score is given, and at the end the scores of the 10 answers are added up, and then they are placed from highest to lowest to know the winners according to their knowledge.

The grade of a test is from 0.0 to 5.00, and it is approved with a value greater than or equal to 3.0, which means that it must be greater than or equal to 60% of the correct answers, regardless of the time, which is only used in case of equal scores between two students. The advantage of answering in the shortest time and receiving a bonus for the next exam. Although the percentage is personal, the percentage of all students is also measured, so the level of the course is known. The group is evaluated with two qualitative characteristics, while each student is evaluated with 5 qualitative characteristics. To obtain the qualitative performance level, the equation is used and the qualitative values can be seen in Table 2.

$$Percentage\ (level) = \frac{100 * note}{Number\ of\ students} \quad (1)$$

Table 2. Personal and course level

Percentage	Personal level	Course level
>=0 y <20	Deficient	Reproved
>=20 y <40	Reproved	
>=40 y <60	Approved	
>=60 y <80	Excellent	Approved
>=80 y <100	Very excellent	

3. Results

In the answer map you can see the 28 answers of the 10 questions, where a colour map has been implemented in order to make a quick analysis easier, Correct answers are green and Incorrect answers are white (Table 3). The map can give us a general idea of how each student and the whole group as a whole can answer right or wrong. In the first two questions all students answer incorrectly, which implies that they feel pressured by the test at the beginning, as the competition progresses the students answer more correctly, however some lose control again and answer incorrectly when they are finishing the questions. If we analyse the motivation in the presentation of the test, it is observed that it is high when comparing tests where there is no competition and no value is given in the student's final mark (Castrillon et al., 2021b), even going as far as not presenting the test or not giving a solution to the questions.

Table 3. Map of responses

Student	QUESTIONS									
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
1	Incorrect	Correct	Correct	Correct	Correct	Correct	Correct	Incorrect	Correct	Correct
2	Incorrect	Correct	Incorrect	Correct	Correct	Correct	Correct	Incorrect	Correct	Correct
3	Incorrect	Incorrect	Correct	Incorrect	Correct	Incorrect	Correct	Incorrect	Correct	Correct
4	Incorrect	Correct	Incorrect	Correct	Correct	Correct	Correct	Incorrect	Correct	Correct
5	Incorrect	Correct	Incorrect	Correct	Correct	Correct	Correct	Correct	Correct	Correct
6	Incorrect	Correct	Correct	Correct	Correct	Correct	Incorrect	Correct	Correct	Correct
7	Incorrect	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct
8	Incorrect	Incorrect	Correct	Incorrect	Correct	Correct	Correct	Incorrect	Correct	Incorrect
9	Incorrect	Incorrect	Correct	Correct	Correct	Correct	Correct	Incorrect	Incorrect	Correct

10	Incorrect	Incorrect	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct
11	Incorrect	Incorrect	Correct	Correct	Correct	Correct	Correct	Incorrect	Incorrect	Correct
12	Incorrect	Incorrect	Correct	Correct	Correct	Correct	Correct	Correct	Incorrect	Correct
13	Incorrect	Correct	Correct	Correct	Correct	Correct	Correct	Incorrect	Incorrect	Correct
14	Incorrect	Incorrect	Correct	Correct	Correct	Correct	Correct	Correct	Incorrect	Correct
15	Incorrect	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct
16	Incorrect	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Correct
17	Incorrect	Incorrect	Correct	Correct	Correct	Correct	Correct	Correct	Incorrect	Correct
18	Incorrect	Incorrect	Correct	Incorrect	Correct	Correct	Correct	Correct	Correct	Incorrect
19	Incorrect	Incorrect	Correct	Correct	Correct	Correct	Correct	Incorrect	Correct	Incorrect
20	Incorrect	Correct	Incorrect	Incorrect	Correct	Correct	Correct	Correct	Correct	Correct
21	Incorrect	Incorrect	Correct	Correct	Correct	Correct	Incorrect	Correct	Incorrect	Correct
22	Incorrect	Incorrect	Correct	Correct	Correct	Correct	Correct	Correct	Incorrect	Correct
23	Incorrect	Incorrect	Correct	Incorrect	Correct	Correct	Correct	Incorrect	Incorrect	Correct
24	Incorrect	Incorrect	Correct	Correct	Correct	Incorrect	Correct	Correct	Correct	Correct
25	Incorrect	Correct	Correct	Correct	Correct	Correct	Incorrect	Correct	Incorrect	Correct
26	Incorrect	Incorrect	Incorrect	Correct	Correct	Correct	Incorrect	Correct	Incorrect	Incorrect
27	Incorrect	Incorrect	Correct	Correct	Correct	Correct	Correct	Correct	Correct	Incorrect
28	Incorrect	Incorrect	Correct	Correct	Correct	Correct	Correct	Incorrect	Correct	Correct

The 10 fastest answers in each question can improve the score of each participant, as long as they are correct; figure 1 shows the fastest times in each of the questions of the whole group, obtaining an overall percentage of 79%, allowing to know that it is an appropriate way to compete and have greater security of the participants, concluding that the faster the response speed the group has better performance.

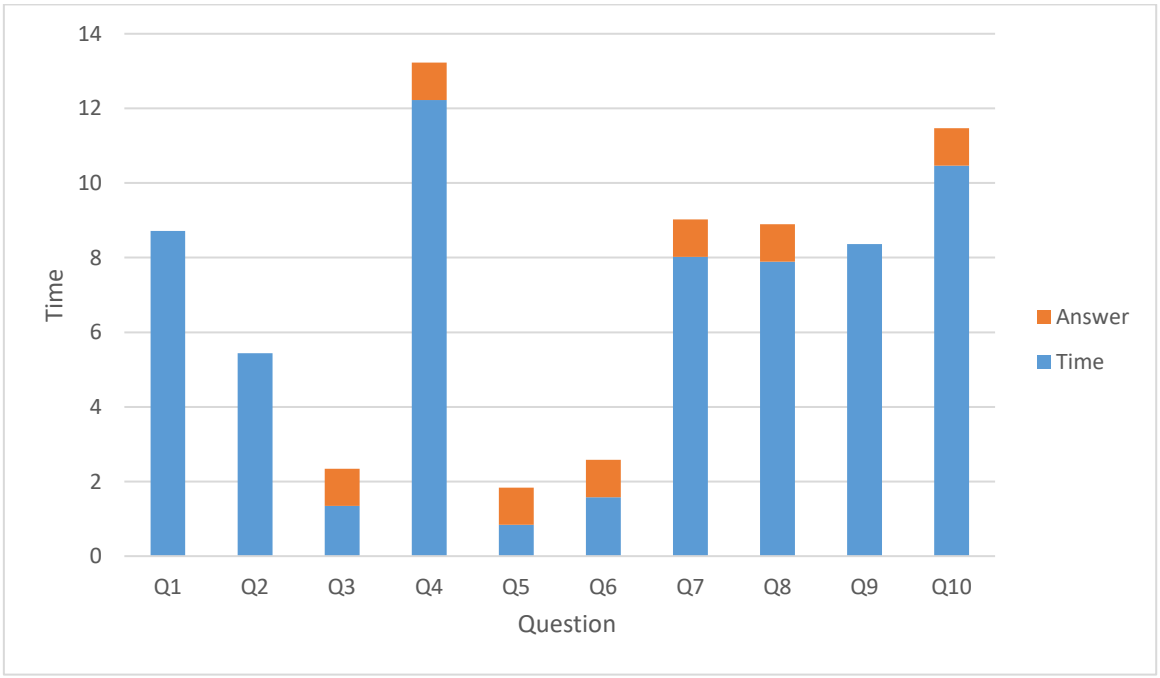

Figure 1. Faster and better response times on each question

When analysing it personally, each time it takes to answer serves to decide a tie-breaker between the competitors, but also allows to increase the overall score, in table 4 you can see the participants with the fastest response in blue, where 2 participants are the fastest in several questions, these participants are

the number 17 and 23; by answering faster can increase the score only if the answer is correct, but has the disadvantage of leading to higher percentage of error. When analysing the fastest answers of participant 17, his percentage of correct answers is 50%, while participant 23 is 33.33%, which shows the disadvantage or improvisation when answering.

Table 4. Response times in seconds

Student	**QUESTIONS**									
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
1	8.961	17.908	15.251	29.476	1.01	3.158	14.388	14.483	15.023	10.468
2	25.021	15.33	2.707	29.634	1.903	7.34	25.538	39.241	24.532	35.017
3	24.724	6.568	3.648	42.687	1.124	3.424	16.039	22.877	16.248	35.838
4	24.991	14.78	14.156	24.204	4.304	4.317	28.835	50.593	16.588	35.202
5	26.087	15.788	7.977	26.035	0.889	9.34	25.858	22.177	13.884	38.689
6	28.218	18.853	7.371	35.46	1.009	1.581	9.075	21.162	25.181	33.738
7	23.569	9.715	2.043	40.368	1.208	1.932	12.026	21.207	12.659	38.073
8	21.375	18.598	1.902	28.539	6.57	7.023	19.612	33.226	38.719	26.299
9	25.374	9.762	2.619	52.176	2.645	2.474	24.48	27.294	26.48	38.214
10	15.611	12.584	12.99	63.343	3.606	12.969	12.848	7.893	12.514	30.526
11	23.246	17.567	13.877	20.167	2.908	8.393	17.208	29.845	18.768	18.629
12	21.019	15.78	12.33	40.572	3.513	3.871	13.083	28.554	50.413	18.266
13	20.962	25.274	11.074	37.097	2.288	7.316	11.08	25.553	50.659	14.953
14	21.264	12.706	22.056	45.794	2.512	23.486	28.304	54.513	54.245	29.666
15	25.988	42.025	4.655	51.465	3.126	3.634	13.041	22.976	16.035	38.961
16	26.803	20.414	3.6	32.886	4.507	21.463	12.214	22.861	26.294	29.843
17	28.375	5.443	3.204	12.226	1	2.347	9.579	11.088	12.932	13.985
18	20.422	16.484	2.676	55.467	3.585	15.764	8.195	26.169	21.212	16.273
19	29.594	12.766	3.389	57.531	5.361	7.26	24.794	42.248	16.811	38.136
20	12.47	12.449	15.574	58.328	6.757	23.994	11.016	22.198	17.178	39.337
21	30	11.226	10.888	32.897	2.111	19.019	26.536	55.791	54.939	20.872
22	28.79	9.474	1.722	23.937	1.142	4.386	8.024	10.543	10.554	23.422
23	8.719	13.392	1.345	29.825	1.869	8.889	20.767	21.907	8.36	18.054
24	26.966	18.372	21.747	24.875	3.177	21.133	13.043	22.522	24.701	29.443
25	29.007	18.716	5.082	20.491	1.866	7.98	26.651	52.985	18.756	20.809
26	30	18.186	10.449	67.355	5.618	14.404	30	10.313	17.756	36.834
27	23.037	28.11	31.062	39.191	5.548	11.376	27.47	50.413	56.64	52.67
28	13.456	18.33	4.485	43.074	0.839	12.603	27.221	22.313	15.986	30.199

The average time per participant and the final position is not directly proportional, the participant who obtained the first place with 9 correct questions, was surpassed by 6 participants with less time, however they were penalised for answering incorrectly, what emerges from the statistics is that you must answer in an average time that fits half the time given in each question to avoid errors, in figure 2 correlates the time, Rank and correct question where you can check the above.

Finally, the percentage of correct answers for the whole group of participants was 68.57%, giving a qualitative pass mark. Table 5 shows the qualitative marks of each participant. The percentage of participants is mostly outstanding with 60.71%, and there are no deficient percentages (Table 5).

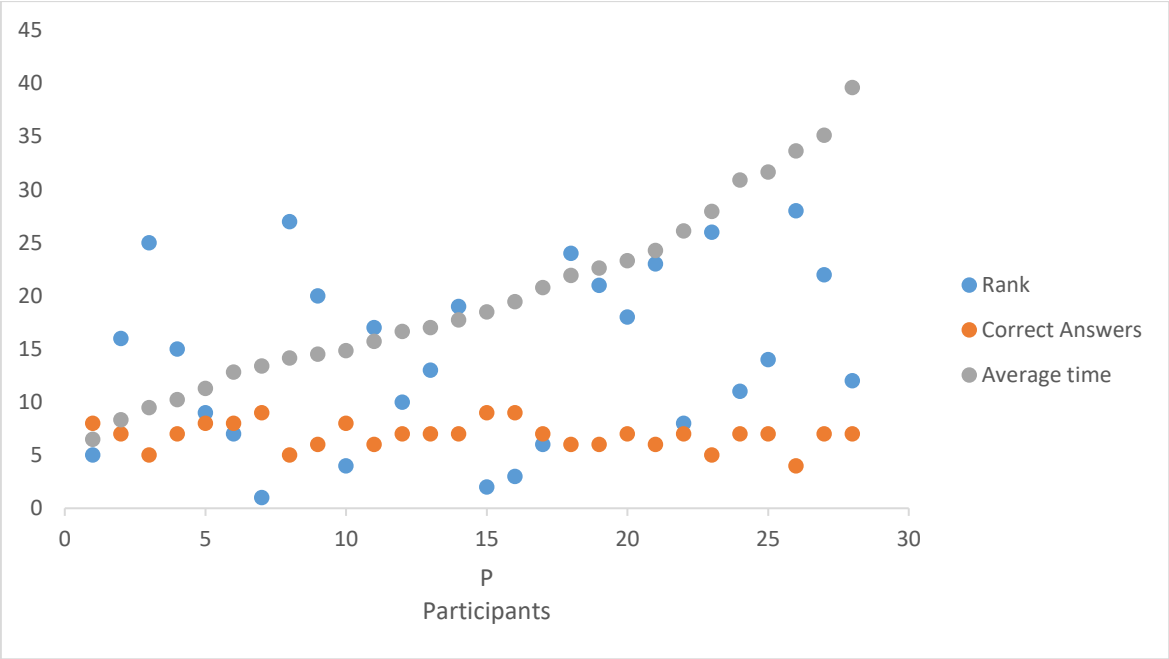

Figure 2. Rank participants

In table 5 and 6, it can be concluded that the test group has a passing performance of 68.57%, while the control group has 53.33%, with a difference of 15.24% of better performance in the test group, in this way using Kahoot through tests where they compete allows a greater motivation and commitment to the course, since it improves the level of repetition of the contents, becoming a tool that helps to create study habits.

Table 5. Personal and test group qualitative level

Percentage	Personal level	Percentage	Course level	Percentage
>=0 y <20	Deficient	0	Reproved	
>=20 y <40	Reproved	0		31.43
>=40 y <60	Approved	14.29		
>=60 y <80	Excellent	60.71	Approved	
>=80 y <100	Very excellent	25		68.57

Table 6. Personal and control group qualitative level

Percentage	Personal level	Percentage	Course level	Percentage
>=0 y <20	Deficient	6.67	Reproved	
>=20 y <40	Reproved	16.67		46.67
>=40 y <60	Approved	23.33		
>=60 y <80	Excellent	40	Approved	
>=80 y <100	Very excellent	13.33		53.33

4. Conclusions

Programming is based on logic, but to get to it, one must have a clear knowledge of the technical concepts, which allows one to find the errors; After conducting the test with two groups, one using Kahoot as a competition tool and the other group in a traditional way, it could be concluded that the use of Kahoot is beneficial, because it increases motivation when the topic to be evaluated has a value as

such in the course grade, also the methodology and constant use of the platform helps students who use it to increase access to content and repetition of the topics seen in class, improving the level of understanding and fixation of the contents. Therefore, the use of game-based platforms, which motivate learning, should be increased, as long as the evaluation percentage has a high value in the final grade of the course.

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