IMPACT OF THE ONLINE QUIZZING GAME 'KAHOOT!' IN THE ACADEMIC PERFORMANCE WHEN USED AS EVALUATION TOOL: A THREE-YEARS STUDY IN A LABORATORY AT THE UNIVERSITY OF LA LAGUNA (CANARY ISLANDS, SPAIN)

SERGIO J. ÁLVAREZ-MÉNDEZ

Instituto Universitario de Bio-Orgánica Antonio González, Universidad de La Laguna, Avda. Astrofísico Francisco Sánchez, 38206 La Laguna, Tenerife, Spain
Departamento de Química Orgánica, Universidad de La Laguna, Avda. Astrofísico Francisco Sánchez, 38206 La Laguna, Tenerife, Spain

JALEL MAHOUACHI MAHOUACHI

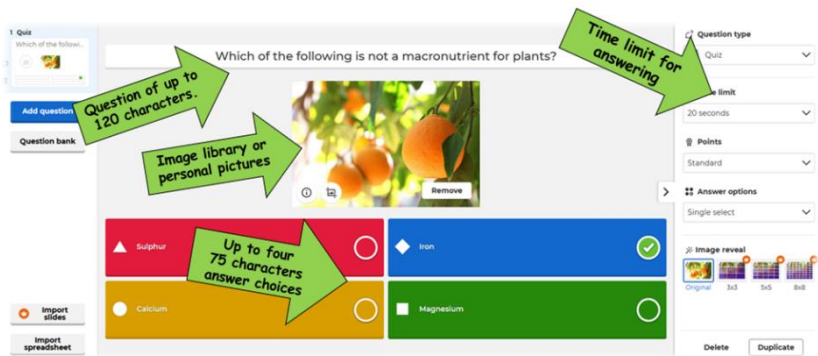
Departamento de Ingeniería Agraria y del Medio Natural, Universidad de La Laguna, Carretera general de Geneto, 2, 38200, La Laguna, Tenerife, Spain

1. INTRODUCTION

Gamification is a didactic technique which consists on adding game-like elements such as progress bars, points, rewards and so on to a non-game task to catch the students' attention and to stimulate their participation (Nah et al., 2014). It is a concept closely linked to game-based learning, in which the learning process itself becomes the game to favor knowledge and skills acquisition (Qian & Clark, 2016), and even to serious/applied games, albeit the latter are more associated to the video-game format (Krath et al., 2021). All these terms share an educative and non-merely ludic purpose. After the irruption of Information and Communications Technologies and the popularization of Internet, teaching methods have progressed allowing online and blended learning, and gamification options has evolved parallelly (Khaldi et al., 2023). The benefits of including frequent quizzes as motivating tool in blended learning has been proved (Spanjers et al., 2015). Several virtual platforms such as 'Kahoot!', 'Socrative', and 'Quizizz' among others allow

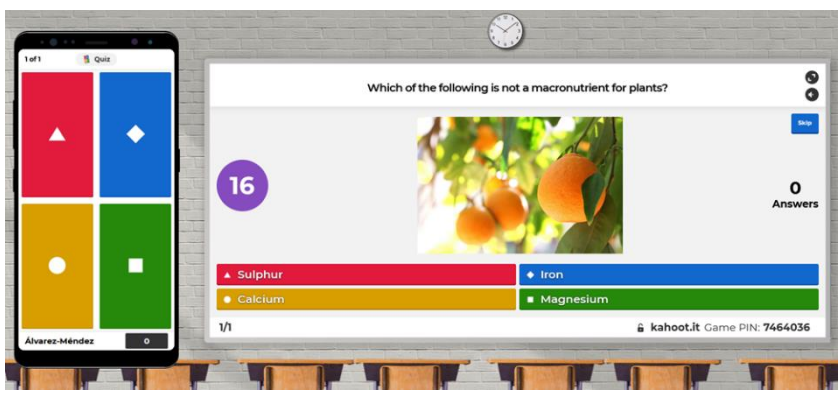
teachers to prepare quizzing games and to share them with their students to be played as a question-and-answer television game show (Ekici, 2021). As an example, FIGURE I illustrates the appearance and user-adjustable features of 'Kahoot!' during the quiz creation process, which can be either from the ground up or adapting others from the library. Once prepared, the quiz game may be shared via a pin code and played individually, in groups, at the students' own pace or live either remote or in classroom. This last case involves a projector and a screen, as well as students' own devices where they can choose the answer from those projected in the screen, as shown in FIGURE 2.

FIGURE 1. *Preparation of a customized quiz game based on single-choice questions.*



Source: own elaboration from https://kahoot.com/

FIGURE 2. *Appearance of the quiz game once released in the classroom.*



Source: own elaboration from https://kahoot.com/

As ‘Kahoot!’ instantly store, analyse and report the students’ answers to the teacher (FIGURE 3), it acts as a web-based student response system (Kocak, 2022). As illustrated in GRAPHIC 1, both ‘Gamification’ as ‘Kahoot!’ have gained popularity during the last years, even more after COVID-19 pandemic (Krouska et al., 2022).

FIGURE 3. *Report of the students’ performance in a downloadable spreadsheet.*

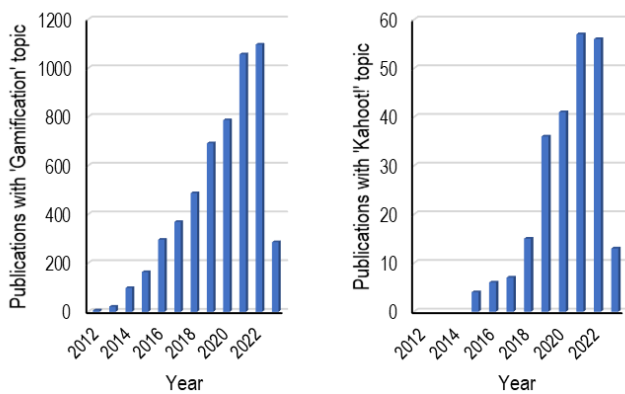
Plant nutrition Exam

Kahoot! Summary

Rank	Player	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
1	Student 3	909	963	884	966	772	0	906	978
2	Student 6	907	0	941	969	937	964	857	858
3	Student 1	856	868	940	831	952	0	887	965
4	Student 2	0	976	758	873	828	916	907	905
5	Student 7	893	778	947	0	811	922	917	773
6	Student 4	859	972	709	967	781	0	853	974
7	Student 10	953	917	939	0	956	0	926	973
8	Student 8	927	963	960	971	922	0	0	932
9	Student 9	0	927	847	788	0	0	764	979

Source: own elaboration from https://kahoot.com/

GRAPHIC 1. *Number of publications by year containing ‘Gamification’ or ‘Kahoot!’ topics.*



Source: own elaboration based on data compiled from a search conducted in Web of Science on 10th May 2023, in which articles, review articles, book chapters and book reviews were selected as document type.

The pedagogical potential of ‘Kahoot!’ have been widely studied since its release in 2013, and many research works have been compiled and discussed in several literature reviews (Ekici, 2021; Wang & Tahir,

2020; Zhang & Yu, 2021). In general, the principal conclusions are that 'Kahoot!' can be helpful improving classroom social dynamics, attitudes and interactions between teachers and students, as well as enhancing learning performance (Wang & Tahir, 2020; Zhang & Yu, 2021). In this context, the literature analysis conducted by Wang & Tahir included 36 studies focused on the learning outcome using 'Kahoot!' as a teaching tool. Thirty of these research papers targeted university students, encompassing diverse disciplines such as language, engineering, science, educational technologies, nursing, and so on. Furthermore, the experiments have been performed in countries as far afield as the USA, Taiwan, Spain, Italy, Norway, etc., which reveals the popularity and the global scope of 'Kahoot!'. Most of the studies about the learning effect derived from the use of 'Kahoot!' are based on a comparison with traditional teaching methods. In most of the reviewed articles, statistical tests demonstrate that groups subjected to game-based learning using 'Kahoot!' significantly improved their academic results when compared to traditional teaching control groups (Wang & Tahir, 2020). However, there are some exceptions in which learning performance worsens or do not change. For example, Ranieri et al. (2021) conducted an experiment involving about 400 students and applying 'Kahoot!' as learning tool in three of the eight total lessons of Educational Technologies at the University of Florence, Italy; in general, they found that students obtained better learning outcomes, although no significant improvement was found for those topics of a more practical nature.

A less common kind of experiment involves the use of 'Kahoot!' for students' evaluation, such as that performed in the context of a lecture about basic computer knowledge at Norwegian University of Science and Technology in 2013 (Wang et al., 2016). A total of 384 first year students were divided into three subgroups (127, 175 and 82 students) which were respectively assessed after the lecture given by the same teacher by means of a conventional paper quiz, a non-gamified student response system ('Clicker') and a gamified approach ('Kahoot!'). Students' motivation, enjoyment, engagement, and concentration significantly improved when 'Kahoot!' was used instead of the paper format.

However, no significant differences in scores were found when compared between paper and 'Kahoot!' formats. This is an interesting and usually forgotten aspect in research about gamified quizzing games: in spite of its huge popularity, there is still a lack of information about how 'Kahoot!' impacts in the students' academic performance when used not as a teaching utility, but as an evaluation tool.

2. OBJECTIVES

The main goal of this work consists on testing during three years the online quizzing game 'Kahoot!' as an alternative format to traditional exams for evaluating students from an engineering degree in a university institution. Concretely, the following aspects are addressed:

- Previous knowledge of the students regarding the existence of 'Kahoot!'.
- Impact of the exam format in the students' marks.
- Influence of the format in the perception of the exams' difficulty.
- Preference of format by the students.
- Collection of subjective impressions, diagnosis of problems and tips for troubleshooting.

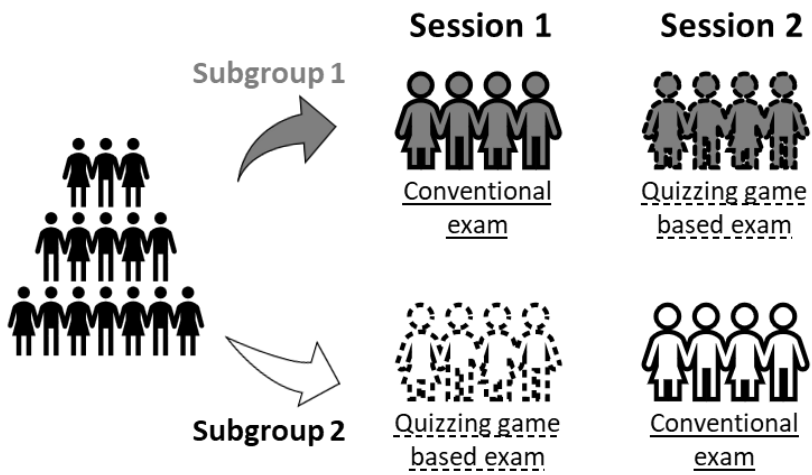
3. METHODOLOGY

'Genetic and Plant Breeding' is a six credits subject (according to the European Credit Transfer and Accumulation System) taught during the second semester of the third course of the degree in 'Agricultural and Rural Engineering' at the University of La Laguna (Tenerife, Canary Islands, Spain). This subject includes four practical laboratory sessions focused on DNA and RNA analyses, and polymerase chain reaction and electrophoresis techniques, by using plant species materials. Students are normally divided into two subgroups for the practical period to

achieve an optimal teacher-student interactive experience and to enhance their participation. Evaluation is performed via an individual laboratory report that must be delivered within a week from the end of each session, as well as by a ten two-choice questions exam which is performed immediately after each session.

This study was carried out in two of the practical sessions during three consecutive academic courses, concretely, in 2021, 2022 and 2023, and the same methodology was followed each year. Over the three studied years, data from 28, 17 and 21 students were collected, respectively (n = 66). During the first session, the first subgroup was assessed via a conventional paper-and-pencil exam, whereas the second subgroup was independently evaluated by means of the same exam but employing the 'Kahoot!' format. For the second session, subgroups and evaluation techniques were exchanged (FIGURE 4).

FIGURE 4. *Methodology based on a subgroups and exam formats rotative strategy.*



Source: own elaboration.

Maximum total time for answering both kind of exams was 3 min and 20 seconds, i.e., a pre-fixed maximum time of 20 seconds for each question in the 'Kahoot!' format and an average time of 20 seconds for question in the traditional format. For each subgroup, it was added a first

non-scoring question in the 'Kahoot!' based exam ('Did you know 'Kahoot!' before this exam?') with a double objective: on the one hand, it allowed us to value the popularity of the platform, and on the other hand, it gave the opportunity of getting comfortable with this format to those students which had not played it before. In each session, marks (from 1 to 10) and impressions about the difficulty of the exams (using a 4-point Likert scale, being 1 very easy, 2 easy, 3 difficult and 4 very difficult) were acquired. As the quizzing game participants automatically get a higher score if they quickly answer the questionnaire, it was established as criterion that only the number of correct answers was considered for obtaining a 1 to 10 score equivalent to that from the traditional exam. The number of answers which students changed by pen in traditional exams was quantified. Finally, after the last session, students were asked by their preference for the exam format (conventional, 'Kahoot!' or indifferent), as well as by their identification with male, female or other genders. Data from those students who changed practice subgroups or who abandoned the subject before the end of the laboratory sessions were supressed and not included in this study.

Data representation was carried out with Excel 2019 version 1808 (Microsoft Corporation, Redmond, Washington, USA), and statistical analyses with the software SPSS Statistics version 26.0.0.0 (IBM Corporation, Armonk, New York, USA). Statistical significances were obtained via non-parametric Mann–Whitney *U* and Kruskal–Wallis *H* tests if comparing 2 or more than 2 groups, respectively.

4. RESULTS AND DISCUSSION

4.1. Uniformity of the studied groups and previous knowledge about 'Kahoot!'

In this study, groups of 28, 17 and 21 students participated in 2021, 2022 and 2023, respectively, with a yearly masculine predominance of the 68, 65 and 76% as shown in TABLE 1. The percentage of male students in the six studied subgroups ranged from 57 to 82%. In total, a 70/30 male/female ratio (46 vs 20) was observed, i.e., male students were as average 2.3-fold more abundant than female ones, as is still usual in

agricultural higher education (Gibbons et al., 2022). No significant differences were found in any of the topics discussed in the present study when considering the independent variable 'gender'.

A reference score was obtained for each subgroup based on the marks obtained in the other laboratory sessions of the subject. Analysis of those average scores with regards to the variables 'year' and 'subgroup' also revealed uniformity in the groups of study throughout the years, which should allow a better comparison of the target scores of this study, i.e., those obtained when subgroups were sequentially examined via the traditional and the quizzing game formats.

By contrast, TABLE 1 also showed a yearly increase in the percentage of students which knew about 'Kahoot!' prior to their participation in this study. Thus, in 2021 only a 43% of the students knew the platform, but this percentage rose to 65% in 2022, and finally reached a 90% in 2023. This increasing trend observed in the number of students that knew 'Kahoot!' before they participated in this study is in line with data shown in GRAPHIC 1: mobile game-based learning has become more popular in the last years (Krouska et al., 2022).

TABLE 1. *Distribution of students (n = 66) during the studied period, reference scores from previous laboratory sessions and prior knowledge about the existence of 'Kahoot!'*

		Number of students				Students which knew 'Kahoot!' before this study		
Year	Subgroup	Male	Female	Total	Reference score*	Male	Female	Total
2021	1	9	3	12	8,17 ± 0,32 a	2	1	3
2021	2	10	6	16	7,52 ± 1,16 a	4	5	9
2022	3	7	3	10	7,40 ± 1,58 a	5	1	6
2022	4	4	3	7	7,86 ± 1,21 a	3	2	5
2023	5	7	3	10	8,60 ± 1,35 a	7	2	9
2023	6	9	2	11	8,55 ± 0,82 a	9	1	10

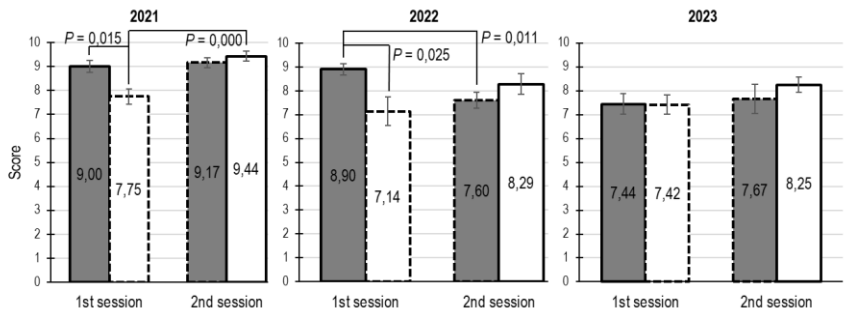
* No significant differences were found in the reference score of the studied subgroups.

Source: own elaboration.

4.2. IMPACT OF THE EXAM FORMAT IN THE ACADEMIC PERFORMANCE

The performance of the students within the same subgroup and within the same practical session was yearly studied considering the variable 'exam format'. For each academic course, GRAPHIC 2 illustrates the average score obtained for the first of the two subgroups in dark grey, whereas average score from the second subgroup is represented in white. Moreover, a plain border line means that the conventional paper-and-pencil exam was used as evaluation tool, while a dashed border line indicates that 'Kahoot!' was chosen as exam format. Scores are expressed as means ± standard errors in all the cases.

GRAPHIC 2. *Scores obtained via conventional and 'Kahoot!'-based exams.*



Dark grey shape's fill (■): subgroup 1; White shape's fill (□): subgroup 2; Plain border line: conventional exam; Dashed border line: quizzing game-based exam. Data expressed as means ± standard errors; *P* values are given for those values in which significant differences were found. Source: own elaboration.

In the first practical session of 2021, the subgroup evaluated via a conventional exam obtained a 9,00 ± 0,25; by contrast, the second subgroup obtained a significantly lower 7,75 ± 0,32 when the same exam was carried out using the quizzing game-based format. When the subgroups and the evaluation techniques were exchanged in the second practical session, no differences were found in the yield of the first subgroup regarding the previous session: their score was independent of the exam format. However, when the second subgroup was evaluated by means of the traditional exam format, their average score underwent a significant increase from 7,75 ± 0,32 to 9,44 ± 0,20.

Similar significant differences were also found during the first practical session in 2022: the subgroup which was traditionally evaluated got an 8,90 ± 0,23 in contrast to the 7,14 ± 0,59 achieved by the subgroup which employed 'Kahoot!'. Again, the second subgroup improved his yield when the conventional exam was used in the second practical session. Interestingly, on this occasion the significant change was found when the first subgroup was evaluated via the gamified exam, since their average mark decreased from 8,90 ± 0,23 to 7,60 ± 0,34.

Regarding 2023, in each of the two sessions the scores were slightly better when conventional exams were conducted. However, on the contrary as we had expected when refence scores were analyzed (TABLE 1), average marks in 2023 were significantly lower than those from 2021 and 2023. Additionally, and independently of the exam format, in 2023 both subgroups improved their marks during the second session, which is in line with the global tendency, i.e., the contents and/or the exam of the second session were significantly easier for the students. These observations are indeed a point in favor to the designed methodology, since the subgroups rotative strategy followed each year allowed us to avoid bias. For instance, merely comparing 'Kahoot!'-based scores with those traditional scores obtained in the same exam by other groups and/or other years, or keeping one unique group to contrast their scores when they are evaluated using the two formats but from different contents.

In summary, the robust protocol presented herein has revealed significant differences in the academic performance when considering the two exam formats (conventional and quizzing game-based), despite covering subgroups with students of different potential and contents/exams with dissimilar difficulties. Thus, a sharp significant decrease in the marks was observed when exams were performed in the gamified fashion instead of the traditional paper-and-pencil format (7.85 ± 0.18 vs. 8.67 ± 0.14, n = 66, P = 0,001).

In the consulted literature, the students' academic yield generally improves when 'Kahoot!' is involved in the teaching-learning process (Ekici, 2021; Wang & Tahir, 2020; Zhang & Yu, 2021). However, less

information is available about the use of 'Kahoot!' for recording academic scores, or about its application in the engineering or science laboratory.

On the one hand, no significant enhancement in the students' scores was found in a similar previous study in which a group of students (127) was assessed via a conventional paper-and-pencil exam and a different second group (82) was evaluated from the same content but using 'Kahoot!' (Wang et al., 2016). This outcome agrees with those shown in GRAPHIC 2 for the second sessions of our experiment, albeit herein we have provided extra useful data due to both groups were subjected to both evaluation techniques.

On the other hand, our study was performed during laboratory sessions, therefore the target topics eminently owns practical features. In a similar case which involves a differentiation between topics of theoretical and practical nature, the employment of 'Kahoot!' only improved the students' academic yield when theoretical topics were taught supported by 'Kahoot!'; by contrast, it was less effective when applied to teaching the most practical concepts of a given subject (Ranieri et al., 2021).

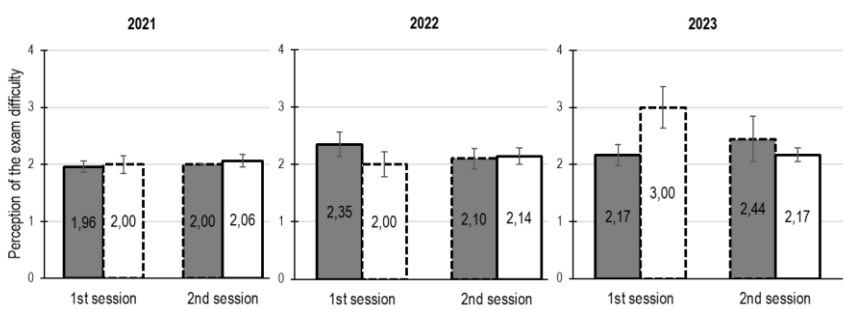
Llanos et al. (2021) used 'Kahoot!' as evaluation tool in three third-year subjects of Chemical Engineering Degree at University of Castilla-La Mancha (Spain). They implemented a 'Kahoot!' exam prior to the first session of two entirely laboratory subjects and also before the practical laboratory sessions of another subject. However, they did not compare the obtained scores with others from control students, since 'Kahoot!' was just used to add an extra motivation for achieving success in the questionnaires.

4.3. Perception of the exam difficulty depending on the format

As discussed above, the traditional format allowed the students to reach an average score 0,82 units (over 10 total points) higher than the quizzing game format. Curiously, the perception of the exams' difficulty did not change significantly based on the exam format in any of the six laboratory sessions executed during the three years of study, not even

in the first session conducted in 2023 (GRAPHIC 3). Thus, no significant differences were found globally in the perception of the inherent difficulty to gamification-based and traditional exams (2.26 ± 0.11 vs. 2.13 ± 0.06, n = 66, *P* = 0,836). By contrast, significant differences were found when comparing this perception by years and session. Indeed, the exam of the first session was considered easier than that from the second session, and students from 2023 perceived both exams more difficult than students assessed in 2021 and 2022. These two findings are in line with the trend observed in the scores.

GRAPHIC 3. *Perception of the conventional and 'Kahoot!'-based exams' difficulty.*



Dark grey shape's fill (■): subgroup 1; White shape's fill (□): subgroup 2; Plain border line: conventional exam; Dashed border line: quizzing game-based exam. Marks based on a 4-point Likert scale, being 1 very easy, 2 easy, 3 difficult and 4 very difficult. Data expressed as means ± standard errors. Source: own elaboration.

4.4. Students' preference for the exam format

After what was shown above, even more curious was that a striking preference for the game format was found instead of the conventional format: 67% vs 23% (the rest of the students did not show a preference by one or another format). Thus, 'Kahoot!' option was 2,9-fold times more preferred than conventional exam, in spite of the general worst academic yield found when this technique was used for evaluation. A 'Kahoot!'-based quiz was also perceived significantly more enjoyable than a paper quiz in a study performed with 384 students in Norway (Wang et al., 2016). The general preference for the quizzing game format sides with widely reported increase of students' enjoyment and motivation when they use 'Kahoot!' (Ekici, 2021; Wang & Tahir, 2020;

Zhang & Yu, 2021), or any gamification technique in general (Nah et al., 2014). In a science laboratory context, Carrillo et al. (2019) found that 'Kahoot!' increased competitiveness, participation and enthusiasm when used as part of a gamified activity carried out in a 2 hours session performed by third course students of the Teaching Training Degree in Primary Education (University of Alcalá, Spain).

4.5. Troubleshooting and tips

Those students who chose traditional format usually claimed that they considered 'Kahoot!' as a short game to be used punctually in the context of an academic explanation, not as an evaluation tool. This appreciation is similar to that reported by Wang & Tahir (2020), who highlighted that some students could feel anxiety and stress under a question-and-answer competition. Poblaciones et al. (2021) suggested as causes of the stress the limited answer time and the possibility of getting a higher score for answering faster. Indeed, other students complained to us that 'Kahoot!' format implied a non-eligible response time for difficult questions. For this study, we had considered that 20 seconds as standard general time was enough for answering each of the questions. In all the performed 'Kahoot!' exams all the answers were recorded in time. The average time taken to answer ranged from 0,63 to 18,69, 0,58 to 18,12 and 0,96 to 15,53 seconds in 2021, 2022 and 2023, respectively. In global, it was not found significant differences between the average answer time consumed in right and wrong answers. Total time required for a 'Kahoot!' session was around 10 minutes, i.e., much more than the sum of the fixed time for each question. By contrast, all the conventional exams were finished before the equivalent maximum time established (3 minutes and 20 seconds). This noticeable difference stems from the extra time required for explaining the exam dynamic the first time, but especially due to the ludic atmosphere settled in all the 'Kahoot!' sessions, where the students tend to comment the evolution of the ranking shown between questions.

The inability to change answers once selected was another problematic issue noted when 'Kahoot!' was used. Conventional exams provide the students the possibility of self-correct their answers once selected by

using crosses, circles, arrows, texts and so on. Indeed, from the 66 students that participated in this study, 11 (17%) reelected at least one answer, and from whom 2 (3%) reelected two answers. Considering the total amount of 660 questions, the 13 revised questions correspond barely to the 2%. Eleven of those 13 questions (85%) were changed to the right options during the review process. Students that changed two answers were twice successful in that process, therefore 9 students (14%) improved their marks thanks to the paper-and-pencil format (7 students improved 1 point over 10 points, and 2 students improved 2 points). Interestingly, 10 of those 11 students (91%) that changed at least one answer chose 'Kahoot!' as preferred option for the exam format, even when this choice would have implied the impossibility of correcting their mistakes. The only of these students who chose the traditional format was one of the two which corrected two answers.

As teachers, an evident limitation that we have found in the quizzing game format is its inherent restriction to academic topics that may be formulated in a multiple-choice format. Complex numerical problems and subjects which need long and well-thought-out discourses are intrinsically limited. Moreover, it has been pointed out that the dependence of an electronic device to carry out an exam can be a handicap, since technological problems such as low batteries or deficient network connections may come to the fore (Wang & Tahir, 2020; Zhang & Yu, 2021). To foresee these possible problems, traditional format exams were available in those sessions which were evaluated using the quizzing game format, although in our case they were never necessary.

On the other hand, some clear advantages for teachers must be brought to the forefront. The conventional exams performed in this study were really easy to correct because they consisted of only ten two-choice questions and the number of examined students was relatively low (n = 66, i.e., 660 questions to be corrected by hand during the study period). However, 'Kahoot!' may gain importance as evaluation tool in crowded lectures or subjects, as in the examples testing around 400 students described by Wang et al. (2016) and Ranieri et al. (2021). As a student response system, another useful feature of 'Kahoot!' is its inherent pos-

sibility to quickly offer teachers access to those questions that are recurrently erred by students. As an example, FIGURE 3 reveals that question 6 was the most problematic of that exam at a glance, so a special incidence in the related topic can be introduced in further lessons to improve the teaching-learning process.

5. CONCLUSIONS

During a study that covered three academic courses, 66 students of the subject 'Genetic and Plant Breeding' were evaluated once by means of a traditional paper-and-pencil exam and once via a digital quizzing game ('Kahoot!') exam during two practical sessions in the laboratory. An increasing trend was yearly observed in the number of students that knew 'Kahoot!' before they participated in the study (from 43% in 2021 to 90% in 2023). According to a Mann–Whitney *U* test, scores over 10 points obtained via 'Kahoot!'-based exams (7.85 ± 0.18) were significantly lower than those obtained via conventional exams (8.67 ± 0.14). No significant differences were found in the perception of difficulty (1 very easy, 2 easy, 3 difficult and 4 very difficult) between 'Kahoot!'-based (2.26 ± 0.11) and traditional exams (2.13 ± 0.06). Pre-fixed answer times, the impossibility of changing answers once selected, limitation in the kind of formulated questions and dependence of an electronic device were pointed out as the main setbacks intrinsic to 'Kahoot!' format. However, 67% of the students chose 'Kahoot!' as preferred exam format whilst 23% opted for the conventional style. In summary, digital gamified exams have looked attractive to the students. Nevertheless, a decrease in their average marks was found in this study when assessing was performed by means of the virtual quizzing game. Therefore, students' evaluation via 'Kahoot!' or other similar online platforms may be counter-productive for the students' academic yield, and their employment as unique evaluation tools should be carefully considered.

6. REFERENCES

Carrillo, D. L., García, A. C., Laguna, T. R., Magán, G. R., & Moreno, J. A. L. (2019). Using Gamification in a Teaching Innovation Project at the

University of Alcalá: A New Approach to Experimental Science Practices. Electronic Journal of E-Learning, 17(2). https://doi.org/10.34190/JEL.17.2.03

Ekici, M. (2021). A systematic review of the use of gamification in flipped learning. Education and Information Technologies, 26(3), 3327–3346. https://doi.org/10.1007/s10639-020-10394-y

Gibbons, J. L., Eguigure-Fonseca, Z., Maier-Acosta, A., Menjivar-Flores, G. E., Vejarano-Moreno, I., & Alemán-Sierra, A. (2022). "There Is Nothing I Cannot Achieve": Empowering Latin American Women Through Agricultural Education. Frontiers in Psychology, 13. https://doi.org/10.3389/fpsyg.2022.902196

Khaldi, A., Bouzidi, R., & Nader, F. (2023). Gamification of e-learning in higher education: a systematic literature review. Smart Learning Environments, 10(1), 10. https://doi.org/10.1186/s40561-023-00227-z

Kocak, O. (2022). A systematic literature review of web-based student response systems: Advantages and challenges. Education and Information Technologies, 27(2), 2771–2805. https://doi.org/10.1007/s10639-021-10732-8

Krath, J., Schürmann, L., & von Korflesch, H. F. O. (2021). Revealing the theoretical basis of gamification: A systematic review and analysis of theory in research on gamification, serious games and game-based learning. Computers in Human Behavior, 125, 106963. https://doi.org/10.1016/j.chb.2021.106963

Krouska, A., Troussas, C., & Sgouropoulou, C. (2022). Mobile game-based learning as a solution in COVID-19 era: Modeling the pedagogical affordance and student interactions. Education and Information Technologies, 27(1), 229–241. https://doi.org/10.1007/s10639-021-10672-3

Llanos, J., Fernández-Marchante, C. M., García-Vargas, J. M., Lacasa, E., de la Osa, A. R., Sanchez-Silva, M. L., De Lucas-Consuegra, A., Garcia, M. T., & Borreguero, A. M. (2021). Game-Based Learning and Just-in-Time Teaching to Address Misconceptions and Improve Safety and Learning in Laboratory Activities. Journal of Chemical Education, 98(10), 3118–3130. https://doi.org/10.1021/acs.jchemed.0c00878

Nah, F. F.-H., Zeng, Q., Telaprolu, V. R., Ayyappa, A. P., & Eschenbrenner, B. (2014). Gamification of Education: A Review of Literature (pp. 401–409). https://doi.org/10.1007/978-3-319-07293-7_39

Poblaciones, M. J., Garcia-White, T., & Marin, C. (2021). Students´ Perception of Real-Time Quiz Kahoot! As a Review Tool in Higher Education: A Case of Study. International Journal of Engineering Pedagogy (IJEP), 11(4), 165. https://doi.org/10.3991/ijep.v11i4.21359

Qian, M., & Clark, K. R. (2016). Game-based Learning and 21st century skills: A review of recent research. Computers in Human Behavior, 63, 50–58. https://doi.org/10.1016/j.chb.2016.05.023

Ranieri, M., Raffaghelli, J. E., & Bruni, I. (2021). Game-based student response system: Revisiting its potentials and criticalities in large-size classes. Active Learning in Higher Education, 22(2), 129–142. https://doi.org/10.1177/1469787418812667

Spanjers, I. A. E., Könings, K. D., Leppink, J., Verstegen, D. M. L., de Jong, N., Czabanowska, K., & van Merriënboer, J. J. G. (2015). The promised land of blended learning: Quizzes as a moderator. Educational Research Review, 15, 59–74. https://doi.org/10.1016/j.edurev.2015.05.001

Wang, A. I., & Tahir, R. (2020). The effect of using Kahoot! for learning – A literature review. Computers & Education, 149, 103818. https://doi.org/10.1016/j.compedu.2020.103818

Wang, A. I., Zhu, M., & Sætre, R. (2016). The Effect of Digitizing and Gamifying Quizzing in Classrooms.

Zhang, Q., & Yu, Z. (2021). A literature review on the influence of Kahoot! On learning outcomes, interaction, and collaboration. Education and Information Technologies, 26(4), 4507–4535. https://doi.org/10.1007/s10639-021-10459-6