Original Article

Continuous assessment and interactive response systems in higher education

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ABSTRACT

There is evidence that the use of information and communication technologies (ICTs) has the potential to improve assessment methods, and therefore, learning process and results. This study compares the effect of two different types of assessment on the learning results of university students: traditional continuous assessment (TCA) and continuous assessment with the interactive response system Educlick (CAE). A quasi-experimental study with 364 students of the degree in Primary Education was conducted. Partial and final marks obtained with TCA and CAE were analysed and the influence of both assessments on the final examination (FE) was considered. It was also studied the different psychological variables that influence the assessment process, which were present in the intervention groups. To this aim, a descriptive analysis of data using the Mann-Whitney and Kruskal-Wallis non-parametric tests were developed through SPSS software. Results revealed a higher percentage of passes (81.5% compared to 74.5%), better marks and higher attendance of the first FE among students assessed with CAE (99.3%) as opposed to students assessed with TCA (91.7%). Findings underline the importance of implementing innovative technological methods, such as the interactive resource proposed in this paper, to develop new and improved skill-based competences in the teaching-learning process. **Key words:** PHYSICAL EDUCATION, CONTINUOUS ASSESSMENT, EDUCATIONAL TECHNOLOGY, INTERACTIVE RESPONSE SYSTEMS, EDUCATIONAL INNOVATION.

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INTRODUCTION

The traditional education system tends to reduce learning possibilities, confining them to formal and closed environments. The challenge of developing innovative ways of learning is complex because we are struggling, on the one hand, with the transformation of learning processes due to accelerated technological development, and on the other hand, with the deficiencies of formal education systems. That is why it is necessary to insist, not only on the display of basic cognitive competences, but also on providing a prominent place to other types of competences related to the management of information, creativity and problem-solving (Ricaurte-Quijano, & Carli-Álvarez, 2016).

Part of the convergence process towards the European Higher Education Area is a commitment to an educational approach based on new methods of teaching, learning and assessing, making it necessary both to incorporate new procedures to access information, and innovate by introducing and promoting information and communication technologies (ICTs) (Martínez-Clares, Pérez-Cusó, & Martínez-Juárez, 2016). Huertas, & Pantoja (2016) argue that ICTs are an underutilised resource in teaching-learning processes and their use would increase the possibilities of transforming the education model involving students, teachers, schools and even the Education Administration.

Measuring the impact of ICTs in the learning process is a present-day topic. In the case of the USA, recent research as the one developed by O'Bannon, Skolits, & Lubke (2017) obtained significant improvements in the performance of university students through the use of the interactive textbook. In addition, participants stated that the iBook provided a new learning strategy and also stressed an increase of motivation towards learning, of emotion as well as of the attention to teaching. In the UK, recent research like Harris, Al-Bataineh, & Al-Bataineh (2016) developed within the school environment, have revealed how new technological models like 1:1 teaching can influence the academic performance of students in a positive manner as well as their motivation to stay at school.

As for the assessment method in teaching-learning processes, continuous assessment (CA) deserves a more thorough analysis to gauge its contribution (Amo, Jareño, Lagos, & Tobarra, 2014; Gracia, & Pinar, 2009; Herradón, Blanco, Pérez, & Sánchez, 2009; Mingorance, 2008; Ricoy, & Fernández-Rodríguez, 2013), in response to the new approach in university degrees within the European Higher Education Area. Moreover, according to Derri et al. (2012), student assessment is one of the critical aspects involved in establishing the educational quality. The key lies in knowing how to use a suitable CA that, as some authors have suggested (Cadetano, & Martínez, 2008; Delgado, & Oliver, 2006; Porto, García, & Navarro, 2013), truly reflects what we aim our students to learn, since the assessment method conditions the learning process; that is to say, what and how students learn depends to a large extent on how they are assessed.

Our interest in evaluating whether CA can help students face the subject leads us to both Gallardo, & Montolio (2010) and Cebrián, & García (2015), who study the relationship between CA and students' results. They conclude that a suitable CA increases their marks. In other words, they find a statistically meaningful positive correlation between CA and the final mark (FM), and they also observe a reduction in the number of absent students. Regarding this statement, it is tested in the present research whether the implementation of this assessment procedure affects the students' attendance rate to this subject, since the fact is relevant to take into consideration.

However, despite scientific evidence, a large number of university teachers still insist on only one final assessment, which is scheduled by the administration department at the start of the academic year. The

application of this type of CA can also be problematic for a variety of reasons, such as high student ratios. Conversely, Llamas-Nistal (2012:51) highlights in his research, in which he conducted a CA experiment both of accumulative evaluation and educational evaluation, "(...) that academic authorities should reorganise the distribution of teachers' academic responsibilities and equitably consider the amount of workload that some of the new tasks proposed by Bolonia imply for teachers, among them, continuous assessment".

The use of new technologies or ICTs, such as interactive remotes, can help us in this CA task. Interactive votation systems or classroom response systems (CRSs) are becoming increasingly widespread in university classrooms. These are manual infrared or cordless devices, similar to TV remotes, although mobile devices, such as phones, smartphones, PDAs or Tablets can also be used. There are also many commercial and free devices such as, Educlick, Powervote, ACTIVote, Turning Point or Opti Vote. The most commonly used hardware is based on remotes similar to a TV's with alphanumeric buttons, which communicate with a base station through infrared or radio waves. Software is required to formulate questions and obtain answers. The CRSs that can be executed in mobile devices use software that can be installed on the same device and works as a response system (Mourín-Moral, 2014).

Suárez-Guerrero, Lloret-Catalá, & Mengual-Andrés (2016) test the transformation of classroom dynamics in BA Primary Education students with the educational use of tablets. They show that this resource enables teachers to work different competences in a cross-curricular manner and assume the challenge of bringing back game or recreational activities as part of learning, in such a way that they conceive tablets not only as a technological challenge, but also as an opportunity to reflect on their traditional pedagogical models (Marés, 2012). That is why in the present study, it has been considered evaluating the degree of motivation that the use of interactive remotes in the assessment process can arouse in students.

In this respect, previous research like Coll, Rochera, Mayordomo, & Naranjo (2007) at the University of Barcelona, have implemented an integrated system of continuous assessment (ISCA) supported by TICs, with very positive results both in students' academic achievements and their satisfaction with respect to the participation in the experience. Similarly, Powell, Straub, Rodriguez, & VanHorn (2011) have analysed the effects of the use of clicker technology as a mean of formative assessment in a university of the USA. In this case, data collected have shown a larger improvement in the academic performance in those students who had used this technology. Additionally, such students faced the use of clickers in this field as an amazing activity. It could then be stated that, according to Ricaurte-Quijano, & Carli-Álvarez (2016), mobile technologies, therefore, are transforming the traditional paradigm since they are expanding learning possibilities.

However, this complex current paradigm presents issues that must be analysed and researched, as the one that led to the beginning of the present research: Will a CA based on ICTs provide an improvement of students' academic performance as well as their psychological skills?

The starting hypothesis at first was that students assessed with an ITC-based CA will have more advantages to sit the final exam as well as better qualifications than the student assessed with a traditional continuous assessment (TCA).

In view of this situation, as we were interested in testing an innovative CA system and based on previously developed research, we designed a proposal of innovative methodology supported and funded by the II In-house Teaching Plan in our own University, under the section "Assistance to innovation and teaching improvement" to be implemented during the academic year 2015/2016. We called the project "Web

Monitoring: an experience of virtual continuous assessment".

The intention of this proposal was to design and assess, in a continuous and innovative manner, BA Primary Education students' learning processes using interactive response remotes. At the same time, it aimed to analyse different psychological variables that influence students along both in the teaching-learning and assessment processes. First, the degree of motivation for the subject along the course was reviewed and the influence of the implementation of this assessment system in the attendance rate was also tested. Second, it was assessed whether this methodology had an impact on students' decision to postpone the subject to the end of the course. Finally, the degree of attention-concentration presented by students with the interactive tool along the assessment process was also evaluated. Other studies (Mourín-Moral, 2014; Peinado-Miguel, Fernández-Sande, Rodríguez-Barba, & Ortiz-Sobrino, 2013; Prim, &Soler, 2009) preceded our innovative experience using the Educlick tool (interactive response remotes) for other goals, such as collaborative works in the resolution of real cases, delivery of contents, or even surveys among teachers of different areas about positive aspects and drawbacks of using response systems in the classroom (Educlick, Powervote or Optivote). As part of the aforementioned teaching innovation project of the University of Sevilla (Spain), we used the Educlick tool in an interactive system of CA between the teacher and students, with the latter performing different tests after the completion of each block of content.

This study has analysed the differences between the implementation of a TCA and continuous assessment with Educlick (CAE) in the study groups, with the following specific objectives:

- Compare marks in different activities with TCA and their equivalents obtained with CAE.
- Check the existence of meaningful differences in marks according to the study groups.
- Analyse the influence of CA, both CAE and TCA, in the final examination (FE) to find out whether it helps them take the first final exam.
- Learn and evaluate the influential psychological variables in students and in the assessment process when using interactive remotes. Understand and analyse the influential variables in the teaching-learning and students' assessment processes.

METHOD

The present research is framed within a quasi-experimental and analytical design.

Participants

By means of a convenience sampling, the research sample was made up of 364 third-year students doing a BA in Primary Education (Physical Education Specialist) at the Education Sciences School of the University of Sevilla, registered for the academic year 2015/16. They came from five of the eight groups taking the compulsory module "Fundamentals and Syllabus of Physical Education in Primary Education" (two morning groups and three afternoon groups). The students who volunteered for the CAE project were registered in groups 1, 3 and 8, whereas the students of groups 5 and 6 studied the subject using a TCA system. Both Table 1 and Figure 1 show the sample distribution.

As it can be observed in Table 1, there is a set of students from group 8 who do not sit the FE, that is the reason why we finally reckoned an N of 346.

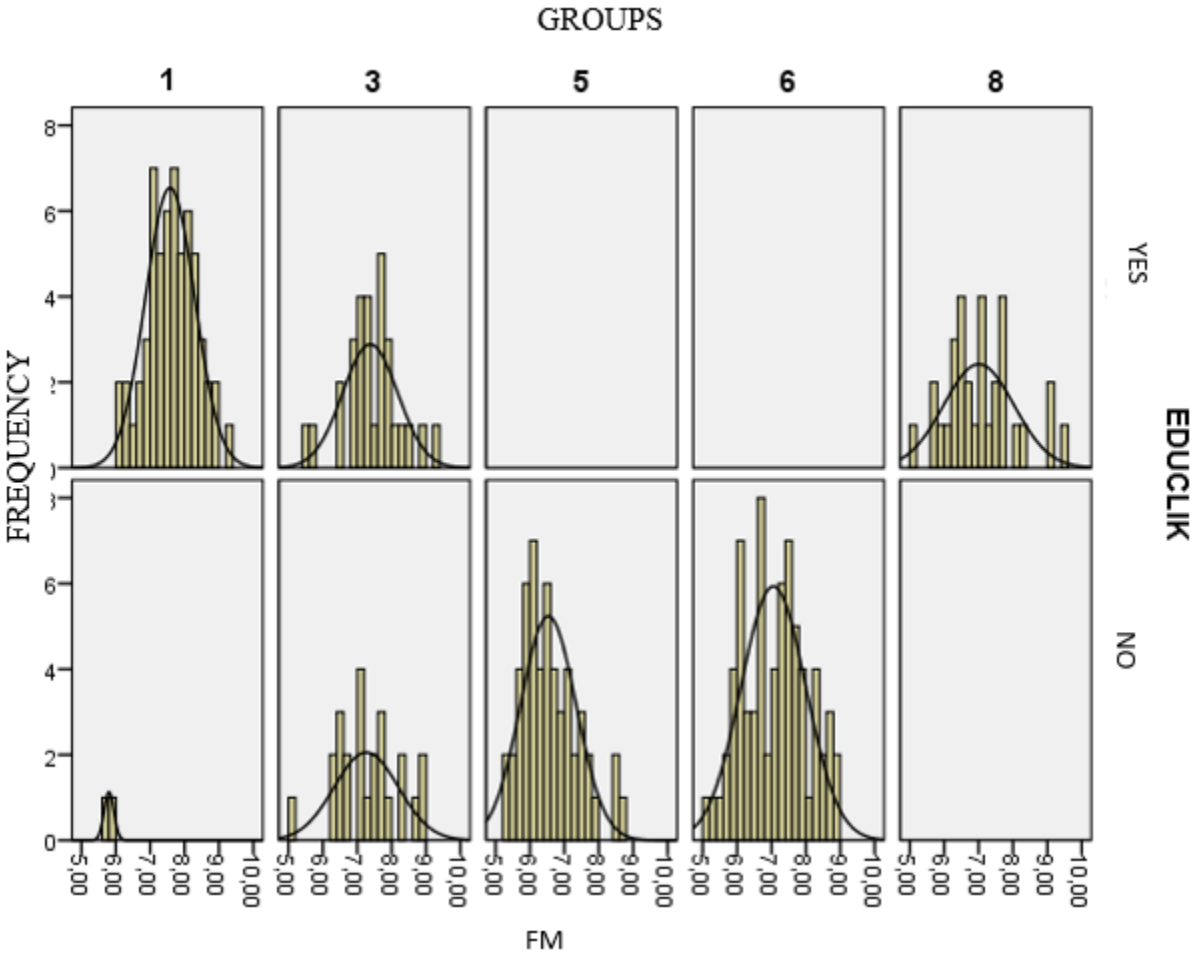


Figure 1. The distribution of groups with a histogram.

Measures

We analyzed the following variables: FM received in the subject "Fundamentals and Syllabus of Physical Education in Primary Education"; FE taken once all the contents of the subject had been covered; mark achieved in CAE activities; and TCA activities of the five groups, all of which are shown in Table 1.

Table 1. Weight of continuous assessment activities towards FM according to group and continuous assessment model.

Group	TCA	W	CAE	FE	N
1		20%	30%	50%	66
		20%		80%	8
3		20%	30%	50%	33
		20%		80%	35

5	20%			80%	76
6	20%			80%	79
8		20%	30%	50%	48
	20%			80%	18
TOTAL					364

Note. W: work; FE: Final Exam; CAE: Continuous Assessment with Educlick; TCA: Traditional Continuous Assessment

CAE variables were studied by means of Educlick interactive tool, which is an interactive response system. This technology is based on a computer software and by means of a projector, questions about the content studied by students are shown and initiated. Each participant answers with a response device.

Additionally, an ad-hoc designed questionnaire for the analysis of the psychological variables that influence the study at the end of the course was used. It was designed with four closed dichotomous questions (yes or no) to know whether development of motivation, attention-concentration, class attendance and coping with the subject along the course not to postponed it for the end of the course were enhanced. For example: "Does this assessment system develop motivation? does it encourage me to attend classes? does it help me not to postpone the subject to the end of the course? and does it develop attention-concentration?" Moreover, at the end of the questionnaire, students responded to an open question named "comments", where each of them freely expressed opinions and perceptions about the experimented model of assessment.

After the implementation of each test with the Educlick tool, participants in CAE were asked to complete a questionnaire designed ad hoc, considering influential psychological variables in the study. Using closed dichotomous questions, it confirmed whether the use of this tool promoted the development of the following variables: motivation towards study, attention-concentration, class attendance and subject confrontation. Additionally, they were able to comment on their perception and evaluation of the methodology used to develop CAE through an open item.

Procedure

During the academic course, after the end of each content block, students completed three exam tests with Educlick interactive tool. These marks were added to those obtained in the FE. After the completion of the tests with Educlick, participants were asked to fill in an ad-hoc designed questionnaire to analyze whether the use of this tool promoted the development of psychological variables, which are analyzed and presented in this research.

In the meantime, the group who had CAT, only did class work, debates and traditional tests for assessment until the end of the course.

Data Analysis

The statistical analysis used an SPSS statistical package (v.22). Normality tests were carried out on data using the Kolmogorov-Smirnov test ($p >. 05$) and we observed that the series did not follow a normal distribution. As a result, we had to develop the descriptive analysis of data and use the Mann-Whitney and Kruskal-Wallis non-parametric tests.

RESULTS

Table 2 displays the FM received by all the students of the module who signed up for the FE[1], according to whether TCA or CAE was used.

Table 2. Frequency and percentage of pass and fail marks in the subject according to the type of CA.

FM	CAE		TCA		
	N	%	N	%	Total
Pass	119	81.5	149	74.5	268
Fail	27	18.5	51	25.5	78
Total	146	100	200	100	346

Results in Table 2 show that the students with CAE had a higher Pass rate (81.5%) in the subject than those with TCA (74.5%).

These differences in students' FM depending on whether CAE or TCA was used were found to be relevant ($p >. 05$) after implementing the Mann-Whitney non-parametric test.

Table 3 details the number and percentage of students who passed and failed the FE of the subject as well as the number and percentage of students who signed up for the first FE, according to the type of CA.

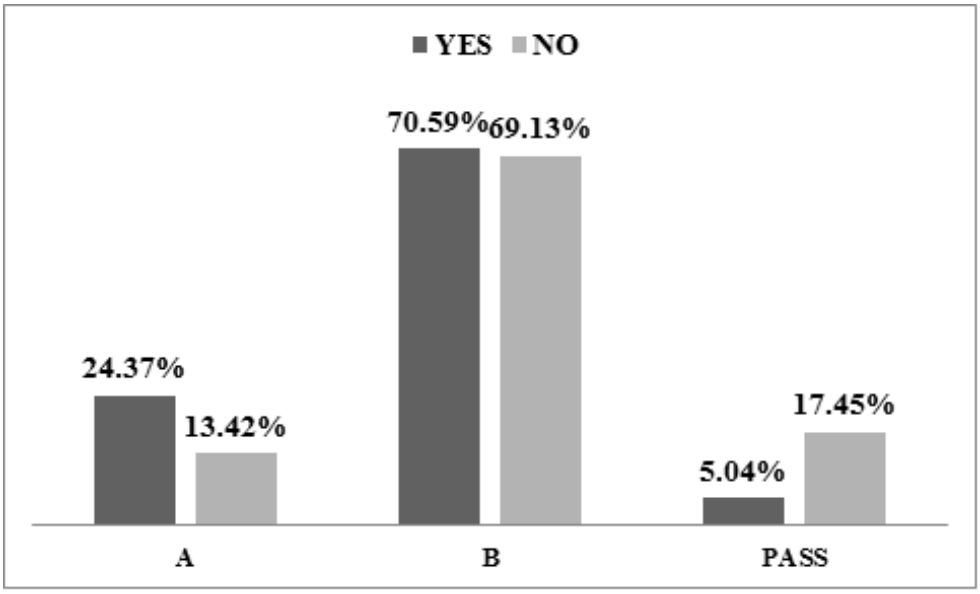
Table 3. FE pass and fail figures according to the type of CA and FE attendance.

	Final Exam						Final Exam Attendance					
	Pass		Fail		Total		Yes		No		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
CAE	104	70.7	43	29.3	147	100	146	99.3	1	0.7	147	100
TCA	147	73.9	52	26.1	199	100	199	91.7	18	8.3	217	100
Total	251	72.5	95	27.5	346	100	345	94.8	19	5.2	364	100

Among the students who attended the FE, Table 3 confirms that the percentage of CAE students was higher (99.3%) than their TCA counterparts (91.7%). These differences were statistically meaningful (p=.01) in the chi-square test. Moreover, the percentage of students who passed the FE was slightly higher among the TCA students. However, such differences were not relevant in this case.

In relation to students' FM, Figure 2 represents the marks obtained depending on whether they had TCA or CAE.

[1] Students can choose when to sit the final exams for each subject, either at the first date in June, or in September. In this paper, when we refer to the final exam we mean the first date.



Pass=5-6.99; B=7-8.99; A=9-10

Figure 2. Marks received by the students depending on whether they had TCA or CAE.

This figure shows that students who were assessed with CAE received higher marks, since 94.96% obtained a mark between B and A, whereas among those assessed with TCA (82.55%) received marks between B and A, with this group having a higher percentage of passes (17.45%) compared to the 5.05% in the CAE group.

Table 4 shows the average mark in the CA of the five groups that constituted the study sample. The highest mean was received by group 1, assessed with CAE, followed by group 6, assessed with TCA. Group 8, evaluated with CAE, was the one with the lowest mean mark. These differences proved to be significant after Kruskal-Wallis test for normal distributions (p >. 05).

Table 4. CA analysis according to group.

Groups	1**	3**	5*	6*	8**
N	66	33	76	79	48
Mean	8.61	7.09	7.31	7.73	6.88
Median	8.66	8.00	8.25	8.00	6.66
DT	.67	2.54	2.62	2.33	1.7

*Note: *TCA **CAE*

Moreover, when analyzing the differences in average marks among the groups specified in the table above (4) with the non-parametric Mann-Whitney test, we found significant differences between groups 1 and 5 (p >. 05); 1 and 6 (p >. 05); 1 and 8 (p >. 05); 5 and 8 (p >. 05); 6 and 8 (p >. 05).

Figure 3 shows the results of motivation, attention-concentration, class attendance and subject confrontation variables.

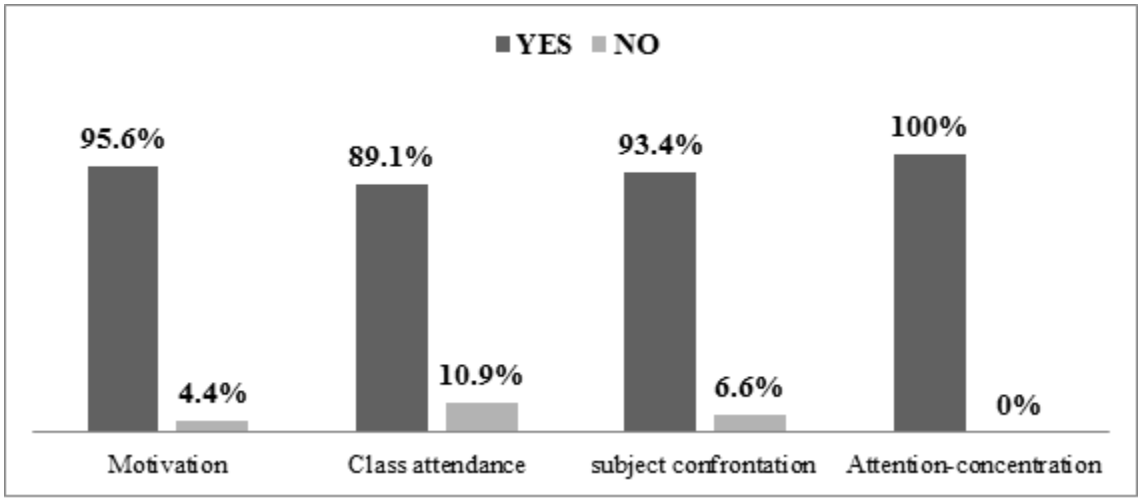


Figure 3. Influential psychological variables in the development of CAE.

Concerning the influential psychological variables in the study, 95.6% of the students noted that CAE had strengthened their motivation to keep up to date with the subject workload, whereas 89% admitted that it had helped them attend classes regularly. In turn, 93.4% of the students answered that this audiovisual resource was useful for the entire subject, while only 6.5% thought this was not the case. Regarding attention, 100% of the sample stated that the tool had increased their level of attention and concentration during the test.

For the results of the open question, students freely mentioned fun, stress, usefulness and innovation, with 15.3% of participants commenting on how amusing it was to work with and be assessed with Educlick; in contrast, 13.9% mentioned that being assessed with this tool was stressful. As for its usefulness, 13.1% of the students revealed a positive perception, whereas 23.4% stated that the Educlick tool was innovative both for its utilization and evaluation of students.

DISCUSSION AND CONCLUSIONS

Data collected allow us to confirm the starting point hypothesis of the study: students assessed with a CA based on the ICTs took the FE in a higher number and had better marks in the subject (FM) than students assessed with a TCA.

Therefore, the present research contributes to increase the scientific field that provides objective data in favour not only of CA in the university field, but also of a type of CA that includes ICTs as significant and positive part of this assessment procedure.

With regard to two of the stated specific objectives: (i) compare marks in different activities with TCA and their equivalents obtained with CAE; (ii) and analyse the influence of CA, both CAE and TCA, in the FE to find out whether it helps students sit the first FE; results of this research highlight the positive aspects of the CAE and the use of interactive remotes. They show that students assessed continuously with Educlick remotes received a higher number of passes in this subject and had better attendance at the first FE. These findings match those of Gallardo, & Montolio (2010) and also those of Cebrián, & García (2015), since they agree that CA (with no further description) reduces the number of absent students in the subject. Consequently, we can conclude that the use of Educlick, as a part of CA, motivates students to follow the module through to the end, reducing the likelihood of dropping out. Similarly, students assessed with Educlick

received higher final marks, whereas students assessed with TCA (based on classwork or debates, among others) obtained lower final marks and more of them failed to attend the first FE.

Regarding another of the stated specific objectives, check the existence of meaningful differences in marks according to the study groups, it was found that the mean of marks of CA was higher in one of the groups evaluated with CAE; that said, another group also assessed with CAE received the worst marks. This could be, among other reasons, due to the delivery of the subjects by different teachers, thereby underlining the importance of different teaching styles in the different groups. This could alter the results in the average of marks with TCA and CAE, a factor that cannot be controlled since groups were assigned to three different teachers. Moreover, we agree with Calvo-Gallego, & Sepúlveda-Gómez (2012) on one of their studies, when they present a thorough analysis of the advantages and disadvantages of the use of Educlick. They highlight that one of the drawbacks is that it derives from an assessment methodology based on multiple-choice questions, which often does not fit the profile or the needs of students, therefore it does not reflect the knowledge acquired as a whole, resulting in lower marks.

It is clear that teachers need prior training and specific practice in the use of the software that controls the tool, a point mentioned by Martínez-González, & Martínez-Carrasco (2015) in their study, where the Educlick tool is used for assessment and learning in Physiotherapy. It is also very expensive hardware and, as Calvo-Gallego, & Sepúlveda-Gómez (2012) also state, it is a method teachers are not familiar with. Nevertheless, relatively few studies have used this tool as part of assessment processes, thus there is a need to continue doing research into the use of the tool in different types of assessment processes, at the initial, training and final assessment levels, together with different ways of approaching such assessments (e.g. cooperative learning or discussions).

Other studies developed about the introduction of ICTs in the classroom, such as for example, mobiles or tablets, reveal that this implicitly includes the development of the psychological skill of motivation (Dhir, Gahwaji, & Nyman, 2013; Leung, & Zhang, 2016), facilitating the learning of contents as long as it awakens the feelings of challenge, curiosity and competitiveness in the classroom (Ciampa, 2014). Fallon (2013) proves that the use of applications with ICTs is an essential condition for learning in a motivating and productive environment. That takes us to the last stated specific objective: learn and analyse the influential psychological variables in students and in the assessment process when using interactive remotes. In the present study, almost all of the participants in the research considered that the use of the interactive Educlick tool increased motivation to keep up to date with the subject workload, it also encouraged students to attend classes regularly and it was a productive resource for tackling the subject. In light of these findings, it is clear that the use of this tool as part of CA helps students face the FE and it motivates them to sit the exam.

Yuste-Tosina, Alonso-Díaz, & Blázquez-Entonado (2012) use the innovation of learning assessment systems by combining a type of virtual assessment and the use of synchronous virtual classrooms with videoconferencing. They test the liability and guarantee of the assessment model of teaching-learning processes, but in a transversal manner, finding that most students consider the assessment method used as highly motivating. Similarly, in the didactic experience developed by O'Bannon,Skolits, & Lubke (2017) with e-books, participants highlighted the new way of learning and emphasised an increase in motivation towards learning, emotion and attention to teaching.

Moreover, studies developed in Latin America (Murillo, & Martínez-Garrido, 2013; Puentes, Roig, Sanhueza, & Friz, 2013; Romá, & Murillo, 2012) conclude that teachers are conscious of the motivating potential of ICTs in teaching-learning processes, recognising that they also promote collaborative learning. In the present

study, motivation is developed in almost all students, allowing them to be updated with the subject contents. This means that the use of innovative interactive tools to develop tasks, such as CA activities, encourages students and fosters interactive, open and rich learning scenarios.

Among the cross-disciplinary competences that ICTs develop in students, such as motivation, they also manage to attract students' attention (Draper, & Brown, 2004; García-Valcárcel, Basilotta, & López-Salamanca, 2014). This study confirms that by using interactive tools to answer proposed questions, all the students showed a high degree of attentional focalisation, developing the psychological skill of attention-concentration. They all reported that the use of CAE was a good technique for increasing these levels as well as actual learning.

With respect to the open comments expressed by students after finishing the tests with interactive remotes, one section of the students reacted positively about the amusement and utility of doing exams with Educlick. This ties in with Martyn (2007) who states that the remote system implies a game-related dynamic, with the resulting increase in motivation.

Many of the students referred to the innovation that the use of an interactive resource meant to them, not just as an innovation in the classroom, but also because they could carry out assessment and examination with it, then that would be a possible resource for those cases which require a change of the climate in class and demand motivational strategies.

This ties in with multiple studies that promote innovation in teaching techniques and the use of ICTs (Johnson, 2004; Serrano, & Prendes, 2012; Siau, Sheng, & Fui-Hoon, 2006). Nevertheless, some of the students stated that the use of response remotes involved a certain degree of stress: on the one hand, due to the suspicion or uncertainty about the possibility of a mistake; and on the other hand, because they did not have enough time to answer. Nonetheless, in retrospect, we consider that this technology should not be used in examinations without previous training for students.

Pérez-Escoda, Castro-Zubizarreta, & Fandos-Igado (2016) present some keys to guide the learning-teaching process in the Z or post-millennial generation, which relies heavily on technology. They propose introducing gamification as a teaching strategy, strengthening motivation, teamwork and development of ethical values.

After conducting this innovative study and considering the results and conclusions, we also need to consider the different limitations the study presents. On the one hand, students' age or gender have not been taken into consideration when registering and analysing data. That could have produced much more specific results according to both factors, as well as having been able to determine whether significant differences arose based on the same factors and check whether they exerted any type of modulating effect on the different assessment processes.

Moreover, and according to what Calvo-Gallego, & Sepulveda-Gómez (2012) state, limitations in the use of interactive remotes like Educlick need to be noted, since they mean an assessment methodology based on multiple choice questions, which often do not match the students' profile and therefore lower marks can be the result. Similarly, it is an expensive technology with which teachers were not familiar, demanding a previous training. Last, we have to note that subjects were delivered by different teachers with their own teaching styles, which could bias both the teaching-learning process and students' marks.

Additionally, after the review of the analysed psychological variables in this study like motivation, attention-

concentration, willingness to attend classes and subject confrontation, it would also have been interesting having analysed other influential psychological variables, like enhancement of students' self-confidence associated with training, that the use of interactive tools in assessment tests means for students; or a more extensive analysis about the stress variable, since data show that almost 14% of students stated in the open question answered on their own initiative, that taking assessment tests with this tool caused a state of tension and mistrust. That is why it would have been valuable to assess this variable after finishing each content block, so as to find out the possible favourable evolution after the training period.

Nevertheless, we feel the need to continue our research in this field. We have to consider that little research has been developed using the Educlick tool or interactive remotes for CA in university students. Consequently, it would be interesting to continue the research on the consequences of the use of this technology in different types of assessment processes. For this reason, following with this line of research, we have designed another Teaching Innovation Project focusing on gamification strategies, ICTs and CA in the classroom to promote student motivation and involvement in the subject. The title is: "Strategies of Gamification, ICTs and Continuous Assessment in the classroom to promote student's motivation and involvement". This project has already been accepted and funded by the II University of Sevilla In-House Teaching Plan, under the section "Assistance to Innovation and Teaching Improvement" to be put into practice during the academic year 2016/17. The project aims to maximise the uses this tool has demonstrated in different studies and minimise the drawbacks of standardised tests as far as possible.

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