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EXAMINING THE EFFECT OF AN ONLINE FORMATIVE ASSESSMENT TOOL (OFAT) OF STUDENTS' MOTIVATION AND ACHIEVEMENT FOR A UNIVERSITY SCIENCE EDUCATION

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Abstract. *Online formative assessment is still challenging although it is getting an increased attention as a significant tool for diagnosing and analysing students' motivation and achievement in various education domains. This research examines the effects of an online formative assessment tool (OFAT) about science motivation and achievement in second-year students' university education during four consecutive academic years, 2014 to 2018. A research on the basis of a randomized experimental design was conducted that assigned groups used an OFAT along with various assessments that students participated. A total of 311 students enrolled in the subject take part in the research, respectively 94, 89, 59 and 71 students. Particularly, the OFAT is offering feedback from students, feedback from lecturers and adaptive assignments. Here, data contained student motivation survey data, standardized achievement pre- and post-test data and students' log records. The results of multiple tier analyses exposed positive effects about students' motivation and achievement. Based on usage measurements, students' intensity offers the positive effects about students' motivation and achievement. Furthermore, along with overall students' improved performance, the effects of high-performing students' achievement were higher. Therefore, the results acquired meaningfully contribute to recover main drawbacks and difficulties of traditional science learning programs.*

Keywords: *adaptive assignment, formative assessment, teaching/learning methodologies, university science education.*

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Introduction

Universities and other educational institutions are adapting their teaching framework to the current students' demands, in which a more personalized assessment is requested. In this context, the online formative assessment (OFAT) is getting remarkable attention. Applying online and blended learning for higher education has extended and become commonplace together with formative assessment in recent years (Hwang & Tsai, 2011; Larreamendy-Joerns & Leinhardt, 2006; OECD, 2015). The effective and efficient digital educational instrument as an active learning methodology has the effect on teaching and learning processes and improves students' motivation and achievement in classrooms (Jeong et al., 2017; Ryan & Deci, 2000; So, 2016). So, it is vital to distinguish and study what limit such tools can affect and how they can be properly implemented (González-Gómez et al., 2020; Maier, 2014; So, 2016). Online learning tools are seen as a promising way to offer various advantages in empirical situations and reveal positive effects of their motivation and achievement proved by a meta-analysis (Asarta & Schmidt, 2017; De Witte et al., 2015). Particularly, the application and utilization of online based learning tools on formative assessment are able to be helpful for students with personalized devices who can use assignments adjusted for the learning necessities (Maier, 2016; Sung et al., 2016; Tsivitanidou et al., 2016). Besides, feedback as a fundamental factor for formative assessment can verify online formative assessment tool effect, while lecturers and students can collect various feedbacks in the passage level for teaching and learning (Mory, 2004; Pape et al., 2012; Pilli & Aksu, 2013).

In order to elucidate how, what and whether an OFAT can give a contribution into teaching and learning quality is necessary in science education, which is still a challenge due to few previous research on the effects of more complicated diagnostic evaluations (Bennett, 2011; De Witte et al., 2015). Its effect differs to the implementation level in the science classroom. Particularly, students' feedback efficacy in OFAT has been under research for several decades and its affirmative effects of educational and instructive outcomes have been

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found in most studies (Bangert-Drowns et al., 1991; Koedinger et al., 2010; Pape et al., 2012). However, these tools in the regular curriculum frequently are not combined (Cornelisz et al., 2015; Shirley et al., 2011), which caused not drawing strong deductions for the tools' contribution to teaching and learning in real settings of classrooms. Besides, these studies are related with small samples together with a short duration study as a further research required (Muis et al., 2015; Narciss et al., 2014; Wang, 2014). Particularly, Sung et al. (2016) mentioned that motivation effects' investigation can be challenging due to novelty effects that can't support and sustain properly. Finally, these OFATs can't attribute their effects because of the absence of randomized experiments since no data of tools' intensity usage is gathered and collected (Hunsu et al., 2016; Koedinger et al., 2010; Pacheco et al., 2018).

This research examined an OFAT effect on science motivation and achievement in second-year students' university education (hypothesis 1). Then, the research assessed to what extent an OFAT usage intensity influences students' motivation and achievement, and lecturers' ones (hypothesis 2). Finally, the research evaluated whether student achievement's effects differ and vary amongst their various levels such as low-, average- and high-performance (hypothesis 3). This research was based on a randomized experimental design, was performed that assigned groups employed an OFAT together with diverse assessments, which students participated during the entire four years courses.

Theoretical Framework and Research Literature Review

Online Formative Assessment in Teaching and Learning

Assessment is considered as a core element that is effective teaching and learning strategies for formal higher education (Bransford et al., 2000), which is required to be assessment-centred and establish increasing abilities as to provide learners with their opportunities and enhancements. Particularly in science teaching, the integration of assessment and teaching must be fostered, and the use of formative assessment must be generalized. Formative assessment has been proved to engage students in applying their understanding of science concepts to real-world contexts (Babincáková et al., 2020; Bulunuz et al., 2014). In 21st century higher education, online and blended learning have increased and converted certain and common position. Online testing assisted by computers is perceived as a promising mode to disseminate the practices of formative assessment at universities (Larreamendy-Joerns & Leinhardt, 2006; Maier, 2014; Vonderwell et al., 2007). Particularly, Larreamendy-Joerns and Leinhardt (2006) mentioned that online teaching and learning can be merged into everyday practices and streams and can increasingly be a salient role of formal higher education. Thus, Vonderwell Liang and Alderman (2007) suggested that online learning formative assessment contexts contain distinct features comparing with face-to-face (f2f) contexts because of asynchronous interactivity characteristic for teachers and leaners, that is, online participants. Therefore, it requires to know what extent and limit such online formative assessment tools affect and how they can be properly implemented (Asarta & Schmidt, 2017; Maier, 2014; So, 2016) and reconsider online and digital pedagogy for attaining effective strategies on online formative assessment for educators (Jeong et al., 2019; Sorensen & Takle, 2005). Online formative assessment tools' effective integration in learning environments has powerful potential to show a proper structure and organization for continuous significant interactions among teachers and learners. It is also to foster effective learning communities' development and expansion as to expedite its significant learning and appraisal (Sorensen & Takle, 2005). However, in online and web enhanced higher education, importance keeps as to be positioned in formative assessment, which is getting little attention in spite of its essential place in supporting learning (Pachler et al., 2010; Wang et al., 2008). None of these fairly recent studies and more analyses focused on assessment that has potential interest, since courses enhanced by online and web provide enough additional chances to animatedly interrelate with and evaluate learners' chances improved via formative assessment approaches (Oosterhof et al., 2008). In this respect, emphasis on OFATs has been recommended by Pachler et al. (2010) and Wang et al. (2008) owing to refocus and build learners and assessment-focused learning situations.

Motivation Effects and Achievement

Few studies on motivation effects to verify OFATs effect are just examined (Ryan & Deci, 2000), although OFATs can improve students' motivation. Positive feedback can be occurred with motivation supportive conditions and competence feelings. Negative feedback together with a very organized digital setting could decrease autonomy motivation and feelings as an obtained result (Carver & Scheier, 1990; Ryan & Deci, 2000). In self-determination theory (SDT), Ryan and Deci (2001) concluded conditions facilitating competence and autonomy feelings enable intrinsic

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and essential motivation only if both feelings are accompanied. In accordance with achievement, self-informed interest, and behavioural outputs, Lazowski and Hulleman (2015) suggested that meta-analyses reveal interventions in the SDT, make positive and affirmative effects on students' position. Pilli and Aksu (2013) discovered a positive and affirmative effect on students' attitudes to measure an online formative assessment tool. For engagement and interest of students, Hunsu et al. (2016) stated a positive and affirmative effect through students' reaction courses of non-cognitive results. Moreover, motivation effects could enhance the feedback use of students that research outcomes designate motivation linked with positive feedback performance; attention reimbursed to feedback, feedback studying time and feedback seeking required (Timmers et al., 2013; Timmers & Veldkamp, 2011). The studied online and digital formative assessment tool includes adaptive assignment together with various feedback types that can be numeracy achievement of students. Here, OFATs frequently stipulate assignments adapted by learning needs of an individual student. Wang (2014) initiated a positive effect of adaptive learning on assignments and materials. Haelermans and Ghysels (2015) also discovered a positive and affirmative effect in the context of numeracy outcomes and claim the effects were instigated through the personalized and modified character of the formative assessment tools. However, those effects mentioned were solely positive and affirmative effects for students of low performance. Low-performing students without adaptive assignments and materials inclined to be confused in digital and online environments. In the same environments, students of high-performance had much less struggles for the assortment of suitable assignments and materials. On the contrary, Cornelisz et al. (2015) stated that adaptive assignments did not have effects and even discovered negative effects on high-performing students' achievements. These researchers claimed that for summative test students were better arranged in non-adaptive assignment than adaptive assignment for students' test prepared.

Various Feedbacks in Formative Assessment

In formative assessment, feedback plays an important role (Duit & Treagust, 2010) and its effect reveals the level to which feedback scheme is reinforced by the findings of the performed research (Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Mory, 2004). Its effect variation relies on a chain of its characteristics and how it associates with situational variances. Studies on effects and correlates of feedback have been recapitulated in a chain of articles, theoretical models, and meta-analyses (Bangert-Drowns et al., 1991; Kluger & DeNisi, 1996; Mory, 2004). Particularly, feedback can verify the effect of online formative assessment tool, while lecturers and students can grasp feedback through the evolution level in teaching and learning (Mory, 2004; Pape et al., 2012; Pilli & Aksu, 2013). First, feedback from students with regard to Shute (2008) was reviewed on its effects, which feedback is much more convenient as if enough time is provided to students who autonomously study in a proposed learning exercise (Kluger & DeNisi, 1996; Hattie & Timperley, 2007). Also, students' feedback efficacy in OFAT has been under research for several decades and its positive and affirmative effects for educational outputs have been discovered in most studies (Bangert-Drowns et al., 1991; Koedinger et al., 2010; Pape et al., 2012). Then, lecturers' comments according to Nunnery et al. (2006) were examined on its effects, in which some findings of feedback create positive and affirmative effects for students' output and achievement in various circumstances (Pape et al., 2012; Ysseldyke & Bolt, 2007). Also, OFATs provide lecturers' feedback for achievement and progress of distinct students together with feedback combined to various class level (Nunnery et al., 2006). The difference between two feedbacks aforementioned is that lecturers not constantly required to utilize the feedback, which they get although effects will be solider if lecturers employ the feedback for improving their instruction and teaching, and align with students' learning needs (Ysseldyke & Bolt, 2007). However, few studies have been conducted to verify the effects of feedback with computer-based instruction, mostly performed in time when formative assessment assisted by computers utilized comparatively simple and clear items on multiple-choice format. Currently, feedback studies have many different domains and digital tools and technologies insinuate a series of new systems of formative assessment and feedback processes. Feedback as a vital factor for formative assessment, therefore, can verify the effects of online formative assessment tool, while lecturers and students can grasp feedback on the progress and evolution stage of teaching and learning (Mory, 2004; Pape et al., 2012; Pilli & Aksu, 2013).

Hypotheses

Digital and online formative assessment is still challenging although it gets an increased attention and there are only few previous research on the effects of more complicated diagnostic evaluations of students' motivation and achievement on learning domains (e.g. science education) based on the overall literature. As a significant segment of

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formative assessment, feedback can verify the effects of online formative assessment tool, which depends on a great scope of the feedback nature specified by certain tools and which are influenced by student characteristics. Therefore, this research targets at examining the effect of an online formative assessment tool together with multiple-tier items on learning test in science education. The hypotheses stated in this research have been listed as follows:

- Hypothesis 1: It is expected that the OFAT studies would have a positive and affirmative effect in science motivation and achievement.
- Hypothesis 2: It is expected that the online formative assessment tool would have more effects if students and lecturers utilize the OFAT to a greater scope.
- Hypothesis 3: It is expected that the effect of OFAT would differ amongst students' performance on low-, average- and high-levels.

Research Methodology

General Background

The research was conducted from 2014 to 2018 with students enrolled in general science course for the primary education bachelor degree in Spain. The research was conducted for 15 weeks, and the participants were randomly allocated in the research. The effect of the online formative assessment was assessed by using the survey as a research strategy. The questionnaires used in this research were intended to gather information about the students' motivation toward the science course, their attitude toward science and their achievements.

Participants

In this research an OFAT was implemented in a general science course for the primary education bachelor degree (second-year students) in Spain during four consecutive academic years, 2014 to 2018. 311 students in total enrolled in the class participated in the research, who did not have any experience with an OFAT. Students who were not consistently presenting to the class were assigned to the waiting-list. Experimental participants used the OFAT for fifteen weeks (between the end of January to the middle of May). Here, the randomization was not based on any criteria influenced. Particularly, there were a total of participants consisting of respectively 94, 89, 59 and 71 students from 2014/15 to 2017/18 course. The actual participation was 92, 81, 57 and 70 (respectively, 97.87%, 91.01%, 96.61% and 98.59% corresponding to each course year). In Table 1, it is described the demographic information of the participants as a descriptive analysis, gender distribution, average age, and grade point average (GPA) at the beginning and the end of the semester based on 0 to 10 scale. No constrains were executed, and the students freely select whether they liked to participate in the research or not.

Table 1
Participants' demographic and academic information for the research as descriptive analysis

		2017/18	2016/17	2015/16	2014/15
Number of students		70	57	81	92
Gender	Male (%)	28.60	35.10	56.80	55.40
	Female (%)	71.40	64.90	43.20	44.60
Average age		20.10	19.90	21.68	19.80
Grade pre-test		6.93	6.90	6.05	5.87
Grade post-test		7.54	7.78	6.95	7.03

The Online Tool of Formative Assessment: PlayPosit

In this research, for acting and performing the formative assessment, the online tool utilized was an OFAT comparable with PlayPosit (PlayPosit, Inc.), previously known as EduCanon. Along with this proposed tool, on their own electronic devices (computer, tablet, smartphone, etc.), students can check, and finish assignments based on

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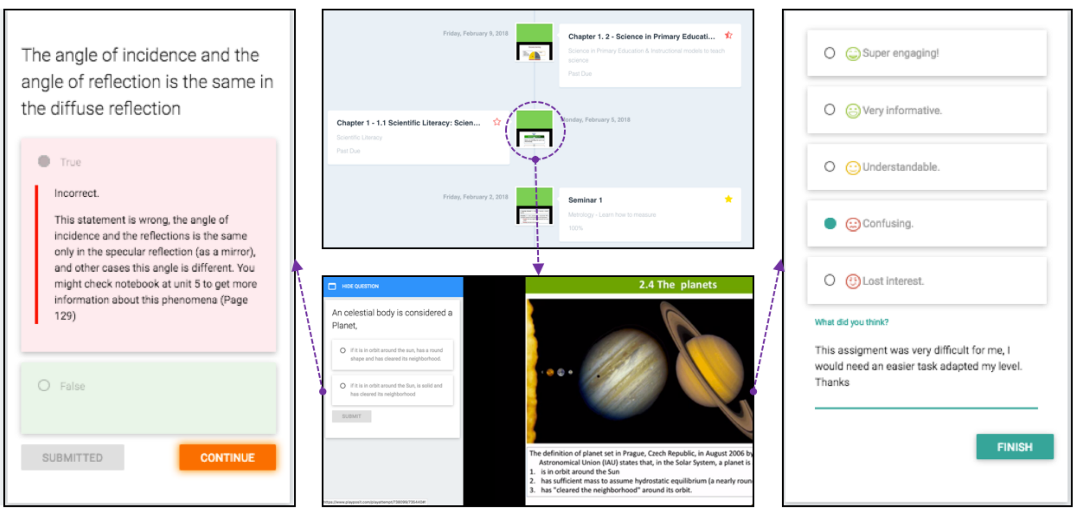
the same instruction content taught in a regular curriculum. Figure 1 describes the OFAT environments for students such as assignments overview with different lessons, each assignment window, feedback after submitted their answer from lecturer and feedback to lecturer.

Firstly, students are registered in PlayPosit and are assigned to the specific one course presented. After log in, students can access to the start screen where the different course lessons with the assignments belonged are scheduled by the lecturers. For each lesson, assignments are presented in the form of short videos (5-10 minutes) that students need to watch and complete the different tasks that are embedded inside the videos. Particularly, this assignment is an enhanced video together with time-embedded interactivity. After completing each particular task, students receive simple feedback immediately from lecturers as soon as they have accomplished an assignment. Here, students will receive the feedback that describes whether their answers are suitable (green background colour) or not suitable (red background colour). Based on this feedback, students might add a comment to explain their answer or demand additional clarification to lecturers. All the tasks must be completed in order to continue watching the video assignment. Once a lesson assignment is finished, students can specify a feedback to lecturers who score their assignment. To envisage the ability phases of students on the basis of their former reactions, the feedback was collected and then their ability levels were recalculated by adaptive assignments completed by students. So, lecturer can decide which adaptive assignments are necessary for students to work on regular curriculum.

Figure 1

A PlayPosit setting for students in science exudation. Image top-middle: assignments outline as scheduled in the course (lessons 1-5)



Note: The figure displays numerous curriculum assignments (videos) associated with a course. After clicking one of the assignment icons, the assignment windows pops-up as a video format embedded question (bottom-middle). When students provide an answer, a feedback is provided based on their answer given (correct/incorrect) (left image) with specific information to assist students to comprehend the question and overcome their fault. Image on the right: student feedback to lecturer. Student can add a comment to explain their answer or demanding additional clarification to lecturer.

Students' progress is followed on the lecturers' dashboard. In the dashboard, it contains three alternatives: a general overview (1), progress monitoring option (2) and a summary of students' global results for each lesson (3). The general overview of the completed assignments (1) shows the number of students that have accessed to the different tasks (views) and the number of students that have actually responded/completed the assignments (videos). With this first part, lecturers check and preview lesson assignments and choose students' assignments. Together with the progress and evolution monitoring choice (2), lecturers track the progress and evolution of an assignment according to a single student or the total classroom. The progress of the assignment choice displays to lecturers how was each student's performance; whether their answers are accurate or inaccurate as well as comments/feedbacks that each student provides to the lecturer. Progress information on a single student informs lecturers about how a student plays for a certain goal in his/her learning. Finally, the third section (3) shows a

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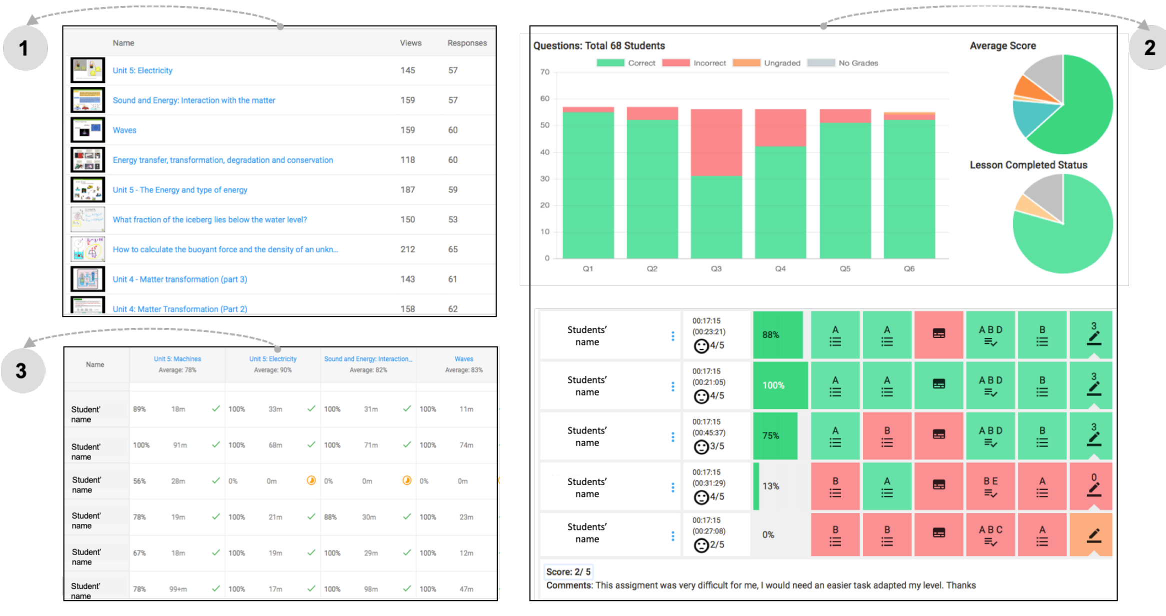
summary of the average results of each student for each lesson considering all the different assignments. With this overview, the lecturers can monitor the students' performance, and suggest adaptive assignment for different situations (low-, average- and high-performance). This adaptive assignment is provided through this online tool and/or the virtual campus tools based on the characteristics of the assignment and/or student. Figure 2 represents a monitoring option example of a class.

Figure 2
Lecturer's dashboard demonstrated a way to progress a class



Note: The dashboard presented has three options: (1) a general overview; (2) progress monitoring option; and (3) a summary of students' global results for each lesson.

Data Collection Instruments

Three different types of instruments were used to get information: the students' motivation survey toward the course and their attitude toward science; standardized course assessments; and students' log records. As shown in Table 1, descriptive analysis is demonstrated for these instruments proposed. All students participating in this research were informed about the research purpose and the data collection practices. Particularly, if there are students who do not want to provide permission to access their data and/or participate in the research, no information was collected for their data to use.

- Students' motivation survey toward the course and their attitude toward science: A survey for students was employed to measure their science motivation once using the OFAT. In this context, motivation toward science must be understood as favourable or unfavourable feeling about science. The questionnaire employed in this research was adapted from Schruba (2008) and consisted of twenty questions such as "Science is something that I enjoy very much". The questionnaire proposed was gauged on a 5-point Likert scale, that is, grading value 1 stands for the most favourable (strongly agree) and 5 stands for the least favourable (strongly disagree). Here, based on Cronbach's alpha, the scale reliability was estimated for this research. The survey was conducted at the beginning (pre-test) and at the end of course (post-test).
- Students' achievements: To assess the students' standardized achievement following the university course syllabus and regulation, different assessment instruments were used along with the course. These instruments were ranged from numerical exercises, quizzes, and essays together with adaptive assignments that students completed at different moments of the course. In addition, a final exam taken at

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the end of the course was used as an instrument to measure the students' achievements. On the other hand, in order to understand the effect of the OFAT, the students' achievement at the end of the course was compared with the grade students accessed at the beginning of the course (pre- and post-test data). Evaluation marks of various courses were articulated on the identical ability mark (0 to 10 scale).

- Students log records: The students' use intensity was gauged with PlayPosit log records (see Figure 2). In these analyses, measures were entered by total completed assignment numbers, the minutes students spent on the web platform, and the views per assignment. These data enumerated by the PlayPosit software then were retrieved at the end of the course. Then, through this online tool and/or the virtual campus tools, adaptive assignments were provided based on the characteristics of the assignment and/or student after monitoring student's performance.

Data Analysis

In order to evaluate the three hypotheses aforementioned, firstly, a descriptive analysis was conducted, which can portray the data as the most correct manner. Here the data can be characterized, described and drawn potential conclusions based on the randomized sample data (González-Gómez et al., 2016; Jeong et al., 2016). In order to extend conceivable conclusions about the effects of the OFAT methodology, sample homogeneity was verified and confirmed. Then, with the Shapiro-Wilk normality test, it was checked and established whether the data described were normally distributed or not. So, it was concluded that data were not normally distributed and, therefore, it was required to use non-parametric statistical test in order to compare the pre- and post-test data as the results. Particularly, the Mann-Whitney test was accomplished as to ascertain the incidence of significant differentiations. In all cases in this research, the SPSS statistical software (SPSS statistics version 22.0) was used to analyse data. Finally, based on Cronbach's alpha, the scale reliability of survey was estimated for this research.

Research Results

The survey used, as research strategy, to gauge the students' motivation toward the course and their attitude toward science consisted of twenty questionnaire items. Among the twenty questionnaire items, significant differences were observed in twelve of them. Table 2 summarizes the twelve items grouped in three categories where significant differences were observed (i.e. only showed the results of course 2017/18), while Figure 3 represents the results for these items for all the studied years.

Table 2
Selected twelve questionnaire items' description grouped in three categories to check the students' motivation toward the course and their attitude toward science (Kaelin et al., 2007)

Category	Number	Description	Pre-test score	Post-test score	*p*
SS	Q1	Science is useful for the problems of everyday life	2.21	1.45	.003
	Q11	It is important to know science in order to get a good job	2.91	2.27	.022
ES	Q2	Science is something that I enjoy very much	3.68	2.39	.000
	Q3	I do not do very well in science	2.50	3.15	.026
	Q4	Doing science labs or hands-on activities is fun	2.53	1.58	.001
	Q5	I feel comfortable in a science class	3.29	2.30	.001
	Q7	Science is easy for me	3.91	3.21	.013
	Q13	I enjoy talking to other people about science	3.59	2.79	.020
	Q14	I enjoy watching a science program on television	324	2.61	.042
	Q15	I am good at science labs and hands-on activities	3.62	2.82	.003
	Q20	I have a good feeling toward science	3.29	2.27	.000
AS	Q19	It scares me to have to take science class	2.97	3.64	.022

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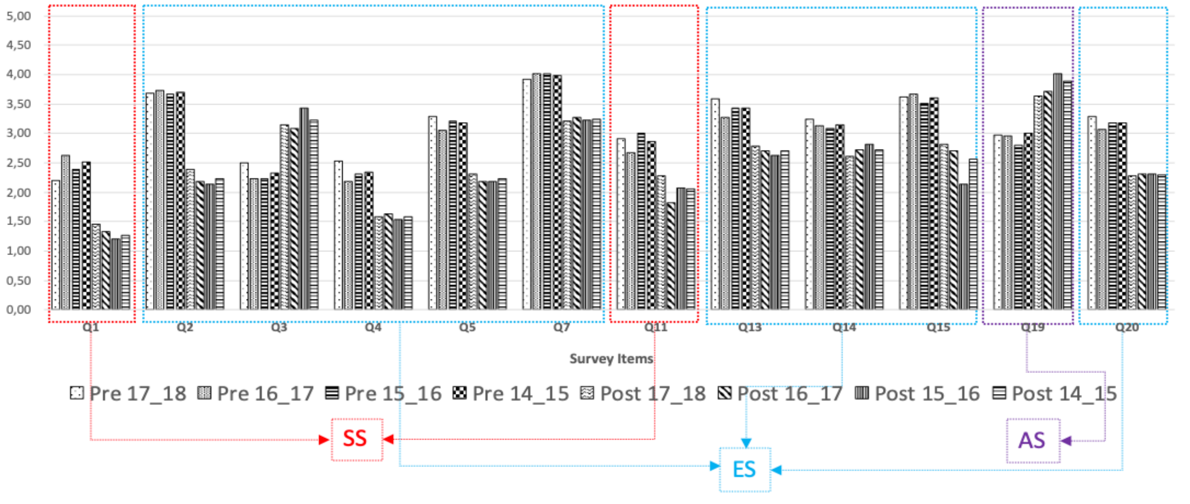
Figure 3

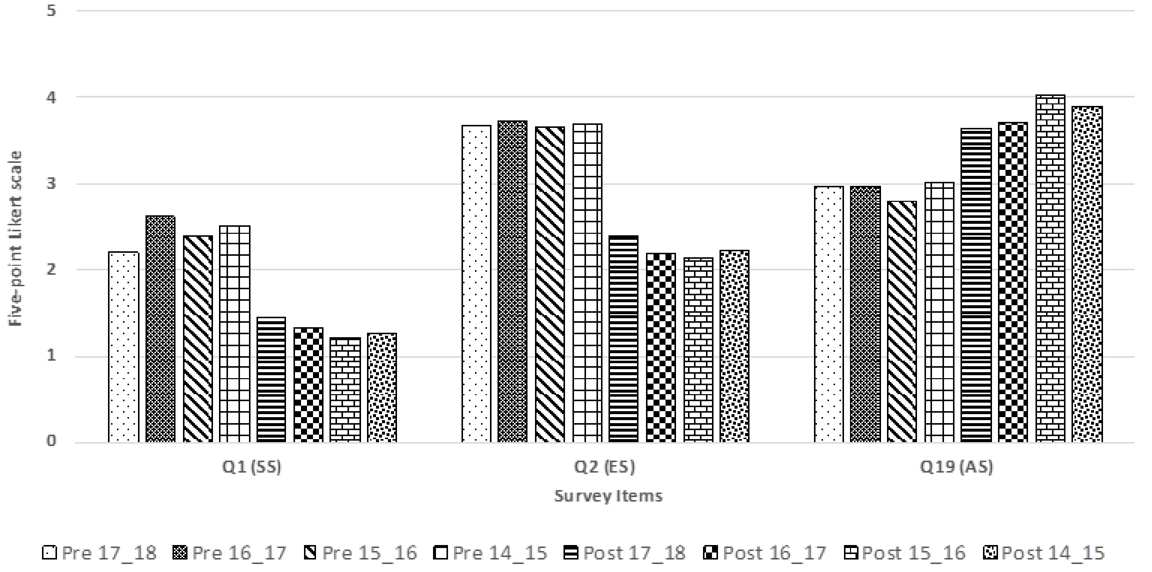
Motivation survey analysis of twenty survey questionnaire items of pre- and post-test data after using the OFAT during four consecutive years in science education



The results of the survey suggested that the implementation of the OFAT methodology influenced motivation toward the course and their attitude toward science, and this effect was consistent within the four consecutive years this research was carried out. The items listed above can be classified in three variables (Schruba, 2008) as "view of society about science (SS)" (items 1 and 11), "enjoyment of science (ES)" (items 2-5, 7, 13-15, and 20) and "anxiety in science (AS)" (item 19). After the analysis of the results, the scores provided by students demonstrated that motivation toward the course and their attitude toward science improved and became more positive, while the anxiety in science decreased between the pre- and post-test for all tested years. The number of items, in which the scores were significantly different between the pre- and post-test, was higher for the category ES, that can reflect an increasement of the students' motivation (hypothesis 1 proved). These results with a significant positive effect are highlighted in Figure 4, which includes one item for each category as an example.

Figure 4

Highlighted survey questions from three different categories of pre- and post-test after using the OFAT for four consecutive years in a science education course



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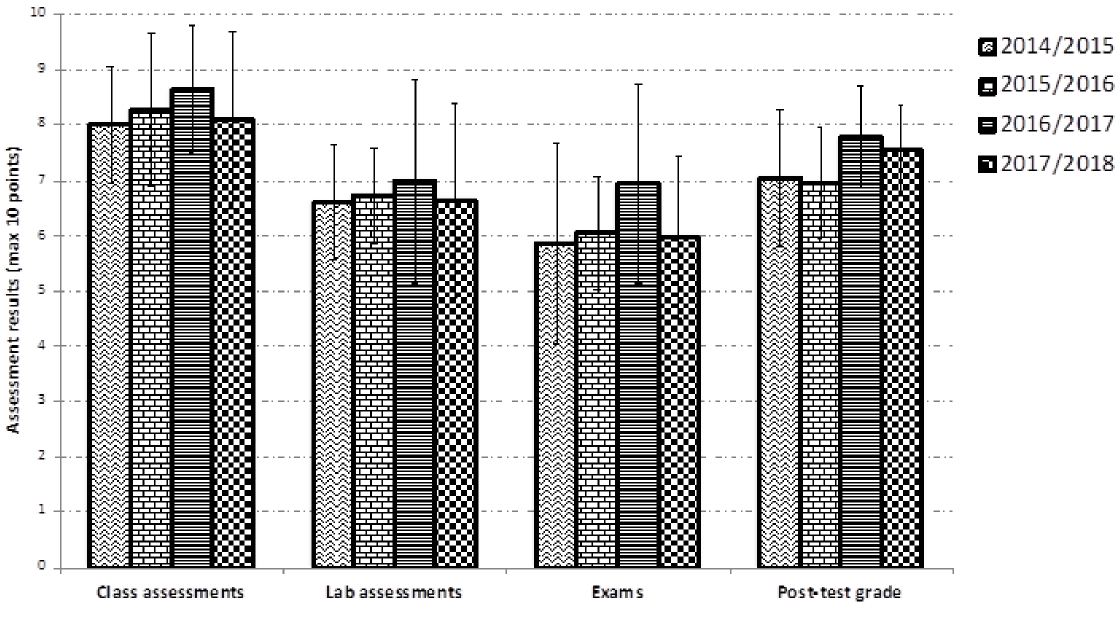
The results of students' achievement aforementioned after using the OFAT were assessed by means of different instruments along the course and showed significant positive results in them (hypothesis 1 proved). Figure 5 summarizes its average values for the four consecutive academic years. The class assessments include the average grade of the assignments done by students in the class-time (numerical exercises, quizzes, and essays along with adaptive assignments). These types of assignments are satisfactorily completed by students, and it is shown in the average grades of the figure that are quite homogenous in all four courses, 2014 to 2018. Lab assignments summarize the marks obtained by students in the lab sessions, including numerical exercises, lab diaries and lab reports. The final course grade (listed as post-test grade in the figure) was calculated considering the final exam grade (70%) and the grades obtained by the students in class assessments and lab assessments (30%). Also, feedback to students with adaptive assignments is a vital feature that concluded to contribute to effects on achievement. The amount of adaptive assignments positively affects students' achievement because they are more focused on students' learning requirements than actual assignments inside of curriculum.

Figure 5
Achievement analysis of students after using the OFAT during four consecutive academic years, 2014-2018



Through the OFAT application, especially in log records, lecturers can access relevant information about the students' interaction with the systems and degree of usage as shown in Table 3 (hypothesis 2 proved). A significant and positive effect can be found of entire assignments accomplished with PlayPosit on motivation and achievement. For this course, the OFAT system containing a total of twenty-eight assignments in the form of video-lesson summing up about 315 minutes in total. The average duration of each video-lesson was around 11 minutes. The total time elapse per student as average was ranged from 980 minutes (course 2016/17) to 1,566 minutes (course 2014/15). This time indicated the total minutes for a particular student, as average, spent working on the OFAT system (watching the video-lessons and answering the different assessments included in the video-lessons). This system also provided the information about how many times a particular student accessed to a particular assignment, regardless the time spent on it. As average, the access per assignment ranged between 138 (course 2016/17) to 231 minutes (course 2014/15). With this information, the average number of access per student was around 2.4 times per assignment. Besides, considering the above-mentioned information, number of minutes, as average, spent per each student in each assignment can be calculated, and it is shown in Table 3, that ranged from 35.0 (course 2016/17) to 55.9 minutes (course 2014/15). That indicates that each student spent, as average, between 3 to 4 times more as the original duration of each assignment. Particularly, we can find out

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an interaction of OFAT effect difference based on students' performance levels, high-performing students had more profits than other students, although overall students' motivation and achievement increased noticeably (hypothesis 3 proved).

Table 3
Description and analysis of log records, the students' interaction with the systems and degree of usage through the OFAT

Description	2017/18	2016/17	2015/16	2014/15
Number of students	70	57	81	92
Total course hours (minutes)	315.07			
Total number of assignments	28			
Average duration of each assignment (minutes)	11.25			
Average time elapse per student (minutes)	1,192	980	1,423	1,566
Average number of views per assignment	163	138	185	231
Average number of views per student	2.33	2.42	2.28	2.51
Average time spent per assignment (minutes)	42.5	35.0	50.8	55.9
Percentage of students completed assignments (%)	89	91	87	94

Discussion

The findings of this research confirmed that an OFAT can get a positive effect on motivation effects of science students' university education. These students' positive effects were predicted because they enhanced their competence feelings through positive feedbacks and performance feedbacks with lecturers. Students' high motivation associates with students' high OFAT usage. Thus, the OFAT's motivation effects will be stronger with more opportunities of students' self-regulated learning in well-structured OFAT and students' completed assignments mostly decided by lecturers. Due to the adaptive assignments, students here can regulate their own assignments more or less fitting to their own learning requirements (González-Gómez & Jeong, 2018; Jeong & González-Gómez, 2020; Jeong et al., 2019). However, the relation effects among frequency usage, motivation and adaptive assignment still remain to be cleared which one is initial effect. Students' achievement was also assessed for this research. The positive effects on student achievement with an OFAT were confirmed by the findings. Lots of former research are following the findings and answers (Babincáková et al., 2020; Bulunuz et al., 2014; De Witte et al., 2015; Koedinger etal., 2010; Pacheco et al., 2018). Here, students using an OFAT to a greater extent achieved better than students using an OFAT to a lesser extent as the importance of students' intensity use, completed assignment numbers. However, it is difficult to state the causing effect liaison between greater scope usage of OFAT and students because more motivated students used OFAT can cause the effects. Still, the students' achievement difference can be proved according to the use of measurement intensity found out in the research.

For an OFAT, feedback along with adaptive assignments to students is a vital feature that concluded to contribute to effects on achievement as a diagnostic assessment. The amount of adaptive assignments positively affects students' achievement due to their concentration on students' learning requirements than actual assignments inside of curriculum. However, the results indicated that there was not specific correlation between significant effect and adaptive assignments percentage due to students spent more time to complete more assignments. Cornelisz et al. (2015) proved that adaptive assignments' effects differ on students' achievement. Also, Huang et al. (2009) pointed out that effects can be influenced by various factors such as learning domain, assignment type and different technique for selecting individual students' adaptive assignments. Comparing with comments to lecturers, it is vital but lower than feedback to students to contribute and underwrite to ef-

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fects on students' achievement. Here, Koedinger et al. (2010) also discovered out stronger students' feedback effects like other researchers. The students' achievement relationship was based on the lecturers' intensity use of OFAT in the classroom that lecturers can receive frequent feedback for daily student's assignments. So, lecturers through this situation can have a better overview on lesson progress and students' assignment understanding and then are easily able to answer and respond their learning necessities and queries. Therefore, it is important to stipulate further research on adaptive assignments' effect together with all education teams who are supporting this new OFAT implemented (Jeong et al., 2019; Shirley et al., 2011).

This research results indicate that for high-performing students an OFAT was effective and successful. Molenaar and Van Campen (2015) also mentioned in the same line research matching the OFATs finding executed in other educational levels. That indicates throughout the studies the obtained findings of high-performing students' achievements are quiet constant and persistent. A potential clarification about the finding of this research is because high-performing students had finished more assignments by the OFAT than in a normal curriculum setting. For example, lecturers can adopt and select additional assignments to students, which the OFAT offers, after completed the normal curriculum assignments. Contrasting to this, a normal curriculum setting does not provide these opportunities that lecturers might have in a lesser extent clarification for high-performing students' effects can be explained according to different educational context and system. Like many researchers mentioned that it would be remarkable that OFATs bigger effects can be found in low-performing students' effects (Koedinger et al., 2010; Pacheco et al., 2018; Sheard et al., 2012) along with international comparative research between comparisons of various levels of students' performances and achievements. It can be argued that different education systems in different countries are focused on the learning necessities of diverse students' levels.

Conclusions

This research aimed to examine how, what and whether an online learning formative assessment tools enhance the teaching and learning practice, especially in on-line education environment, that is in fact growing quickly. This research established the effects of the OFAT, named PlayPosit, on students' motivation and achievement during four consecutive academic years. A research on the basis of a randomized experimental scheme was conducted for inspecting these effects in trainer teaching students for the primary education bachelor degree in Spain. Moreover, in a normal classroom setting, we can gain more understandings about the OFAT effects and use through the OFAT intensity usage dimensions of students and lecturers. Also, the results of various-performing ranks of students were included to know the different achievement effects of the OFAT. Generally, the results of this research confirm that the OFAT can attain a positive effect in student motivation and achievement of science education as a diagnostic assessment. Also, the research reveals that the OFAT is even more effective and operative since students and lecturers utilize it to a vaster extent. In the case of students, with more its intensive use they attained the higher level of science motivation and achievement. In the case of lecturers, they differentiated their instruction with various feedback affecting students' motivation and achievement. Finally, the OFAT showed its different effect between low-, average- and high-performing students. Therefore, this research recovered main drawbacks of traditional science learning programs that are not in regular curriculum, with small samples with a short duration, due to novelty effects and without randomized experiments. Particularly, there is more room for more intensive OFAT use that will perform a significant power to interact students and lecturers and affect stronger students' motivation and achievement with better lecturers' professionalization in science education.

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