

Formative assessment: quick surprise quizzes online in class in mathematics higher education

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In literature, moments of Active Learning in which all students are working effectively are considered an added value. Even better if, at the same time, they provide a formative assessment opportunity in which students receive immediate feedback. Thus, in a Calculus curricular unit, 31 online surprise quizzes were administered in Moodle to 112 students, distributed across nearly all classes. Students can repeat the quizzes as many times as necessary until they obtain the correct answer, without grade deductions. In an anonymous online survey, almost every student indicated that the quizzes were useful. Although they were not mandatory, the participation rate was very high. Many mentioned they were more attentive due to the quizzes, finding them useful for feedback, for understanding the level they were reaching, and for learning new things. Teachers also confirm that it is a pedagogical strategy worth maintaining.

Keywords: Quizzes, Moodle, formative assessment, active learning, feedback.

Introduction

Quizzes are part of several successful approaches with different kinds of students, both in top universities and in other higher education institutions. Examples of these include TEAL (Dori & Belcher, 2004) at the Massachusetts Institute of Technology; SCALE-UP (Beichner et al., 2007) at North Carolina State University; Peer Teaching (Lasry et al., 2008) at Harvard University; Online Learning Modules (Hill et al., 2015) at the University of Sydney.

Particularly, in the teaching of mathematics in Higher Education, there are many different strategies to apply quizzes: as either formative or summative assessment; online or in-class; mandatory or optional; weekly or with other periodicity; generate new instances for each student or not; give penalties for submitting the answer more than once or not; only multiple-choice questions or more sophisticated ones, etc. Researchers are still looking for the best combination. Some approaches can be found in Siew (2003), Varsavsky (2004), Blanco et al. (2009), Lim et al. (2012), etc.

The National Center for Public Policy and Higher Education in the U.S.A. (Twigg, 2005) refers to computer-based continuous assessment and feedback as a key strategy for quality improvement. Shorter and Young (2011) made a comparison of three assessment methods: (1) daily in-class quizzes, (2) online homework, and (3) project-based learning. They found 'daily in-class quizzes' to be the best predictors of students' learning for 117 undergraduate Calculus students.

Making surprise quizzes carried out during classes makes quizzes an Active Learning activity, that is, a moment in which all students are actively working. This adds even more value since it provides

immediate feedback to students (Booth, 2012), forces students to be more attentive in classes and increases competitiveness (Nadeem & Al Falig, 2020).

Taking all this into account, the online surprise quizzes described below were applied in class.

Context

This research took place in the school year of 2023/24 in the course of Mathematics Applied to Engineering (Calculus with applications) belonging to the first year, first semester of the graduation in Computer and Multimedia Engineering of the Polytechnical Institute of Lisbon, Portugal. The researcher has been responsible for this course for some years and this year surprise quizzes were introduced in class. Weekly quizzes have been held for several years, but outside of classes. These quizzes appear from time to time in classes, typically after finishing a subject. In general, there is one quiz per class, sometimes at the end of the class, sometimes in the middle and, sometimes at the beginning – referring to the material that was taught in the previous class. We have three classes per week, lasting 1h30 each and we made a total of 31 quizzes.

Some of these quizzes have different questions for each student (randomly generated using some variables), but most are the same for all students. Everyone can try to answer the quiz as many times as they want, the grade will not be discounted. It is natural for students to talk among themselves, compare the results, and end up all having the full score. This is not discouraged, on the contrary, mutual help is encouraged. These quizzes are not mandatory and count very little towards the final grade. They only count if the grade in the exams is higher than 9.0 and if they improve their grade, in which case, counts 5% of the final grade.

The quizzes were mostly used from the weekly quizzes that had already been created for the course, some were new. Both these quizzes were made available on Moodle – the Learning Management System of the Institute. These quizzes were simple, we tried to choose or create simple questions that do not use much class time. The quizzes were mostly answered in class, but sometimes there was no time to finish and then the students finished at home. The quizzes were only available to students of the class that was taking that quiz, from the time it opened, until the end of that class (typically).

The course had 112 subscribed students, with 6 being considered ghost students since never answered any class quiz, weekly quiz, test, or exam. Classes are not mandatory. The students who went to any class were 103, distributed this way: the researcher was a teacher in two daytime classes, T11D with 37 students and T12D with 36 students. The other teacher on the course had a night class T11N with 10 students and a daytime class T13D with 20 students.

The aim of the quizzes was not to assess students, but to make them be more attentive in class, study more, not to postpone, not to study first the other subjects that naturally are more pleasant to them (since they belong to their study area), and to make students be aware of their level of understanding (often students only realize that they cannot solve the exercises when they get the first test -- in the middle of the semester). Students usually are optimistic about their capabilities (Wandel, 2015) and quizzes help them to be realistic. It was written in Moodle and teachers repeatedly reminded students that the aim of quizzes was to make students be more attentive, study more and be aware of their level

of understanding; students may copy all quizzes, but probably will not get the requested values in ‘regular’ assessment and it will not be worthwhile.

One of the advantages of quizzes being online is that they are self-corrected, and we can present them to large classes with little effort to create them and no effort to correct them. Maintaining the advantage of scaffolding the questions as well as in paper and pencil.

There were quizzes on all subjects. Typically, the teacher explained a subject and at the end made a quiz about that subject. It's interesting that in some classes, even in the last few days, when the quizz opened, everyone was attentive and working.

The quizzes

The quizzes were produced through the ‘Moodle activity’: ‘test’. We created one quiz and then use the “duplicate” option to replicate it to all the four classes (Figure 1.a)). However, for the next year, we will create just one quiz and open and close the same test every time we are in a class to create just one quiz. Students don't know what the quiz will be about (it's hidden, only visible to the teacher). Quizzes allows the introduction of images, and mathematical symbols using LaTeX, see Figure 2. Some students answer it on the smartphone others on laptops. It perfectly fits a smartphone, as we can see also in Figure 1.b) and c).

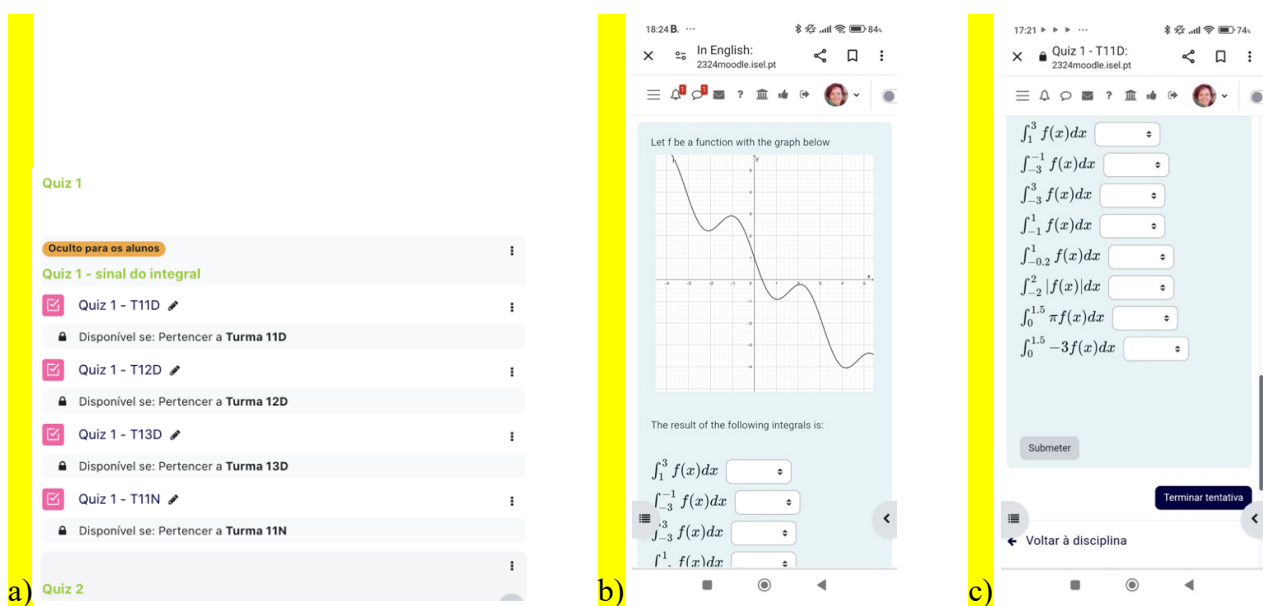


Figure 1: a) The same quiz for the 4 classes, with the theme hidden for the students. b) and c) Quiz including a figure and mathematical symbols. Screenshot of a smartphone

Each quiz had just one question. Sometimes the questions are multiple choice like in Figure 2b) and c); other times they are numerical response as in Figure 2, and others have both as in Figure 3. Sometimes the question is the same for all students; other times it is an instance of the question with some randomly generated values, see Figure 2.

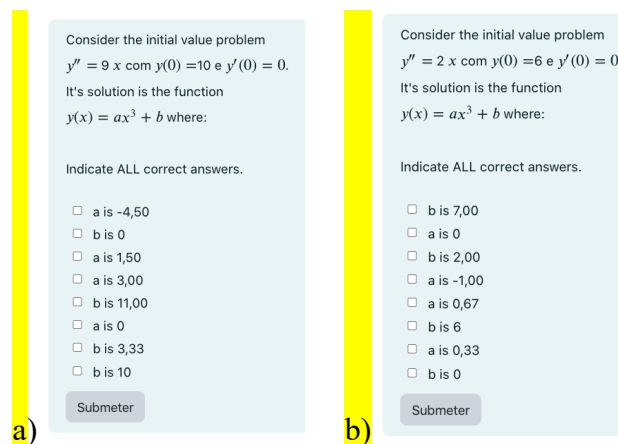


Figure 2: Two instances, aleatorily generated, of the same question, using numerical questions

By “submitting”, students receive feedback, knowing which answers are correct and which are wrong. The next attempt already includes these answers; they just need to change them, see Figure 3.

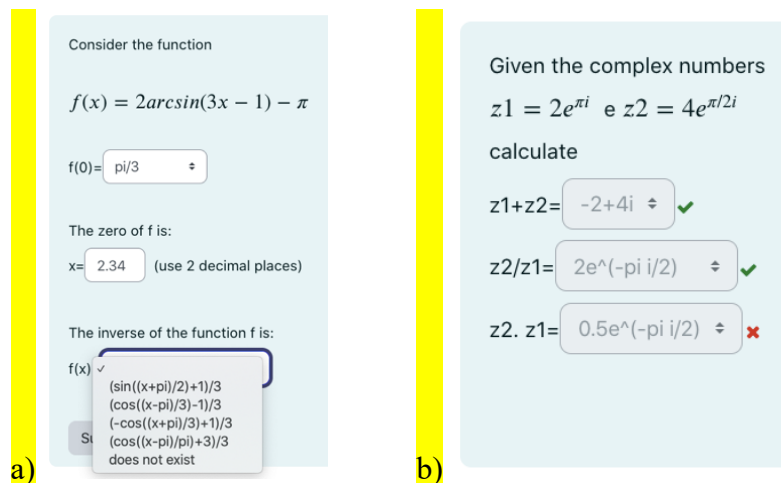


Figure 3: A question with numerical and multiple choice questions. And the feedback.

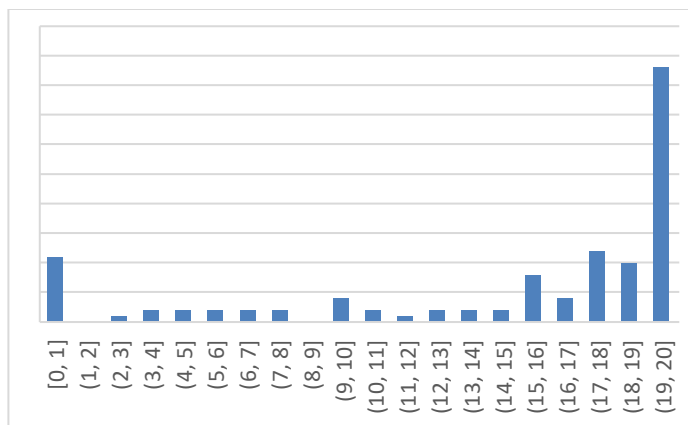
We were creative when making the questions allowing to evaluate all subjects, even those who seem difficult to evaluate using only numerical and multiple choice questions. The grades are all saved in Moodle, and it is very easy to export them.

Methodology, quantitative and qualitative data, and discussion

The research question is whether these quizzes are seen by students and teachers as an added value. To this end, a quantitative and qualitative study was carried out. The two research methods used were Survey and Interviews (Cohen, 2007). As tools, an anonymous survey, online in Moodle, was made available to all students on the course. And an Informal Conversational Interview of teachers regarding this new pedagogical practice was also collected.

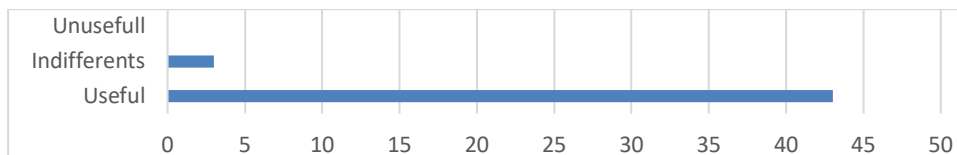
There was a total of 31 surprise quizzes in 39 classes of 1h30 each class. The course had 112 subscribed students, with 6 being considered ghost students since they never answered any class quiz, weekly quiz, test, or exam. Classes are not mandatory. The students who went to any class were 103. All 106 students (non-ghost) answered at least one quiz; of those, 96 students (91%) obtained a quiz

average above 5 out of 20; 77 students (73%) got a quiz average above 15 and 43 students (41%) obtained a quiz average above 19 out of 20 having answered almost all the quizzes with almost everything correct – as it is expected, since they may go to all classes/quizzes and when they have doubts solving, they can ask for help from the professor and from the classmates. This shows that the student participation rate was very high (see Graphic 1).



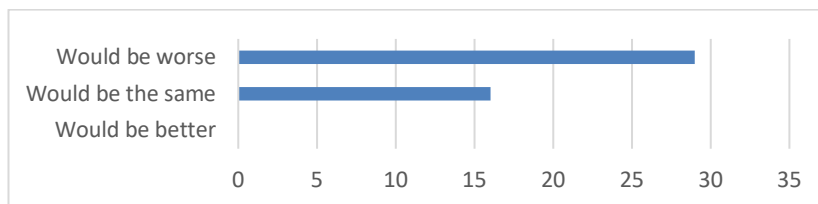
Graphic 1: Quizzes average grades histogram

The respondents to the survey were 47, representing 46% of the students who went to at least one class, with a representative distribution of student grades, including approved and failed students. About the question "Do you find the quizzes:" (Graphic 2), 43 find it useful, 3 indifferent and 1 didn't answer. So, 92% find it useful.



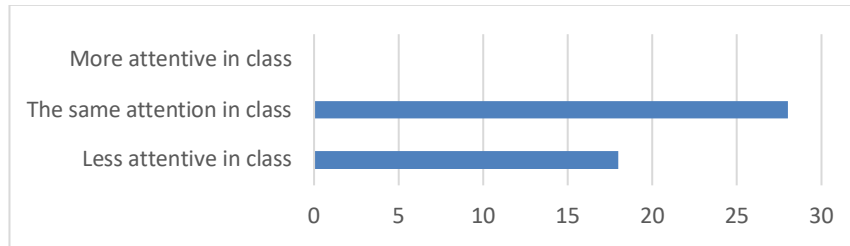
Graphic 2: Answers to the question "Do you find the quizzes:"

About the question "If there were no quizzes, do you think your grade would be different?" 29 think that it would be worse, 16 think that it would be the same and 2 didn't answer. Then, 62% believe that it makes them have a better grade (see Graphic 3).



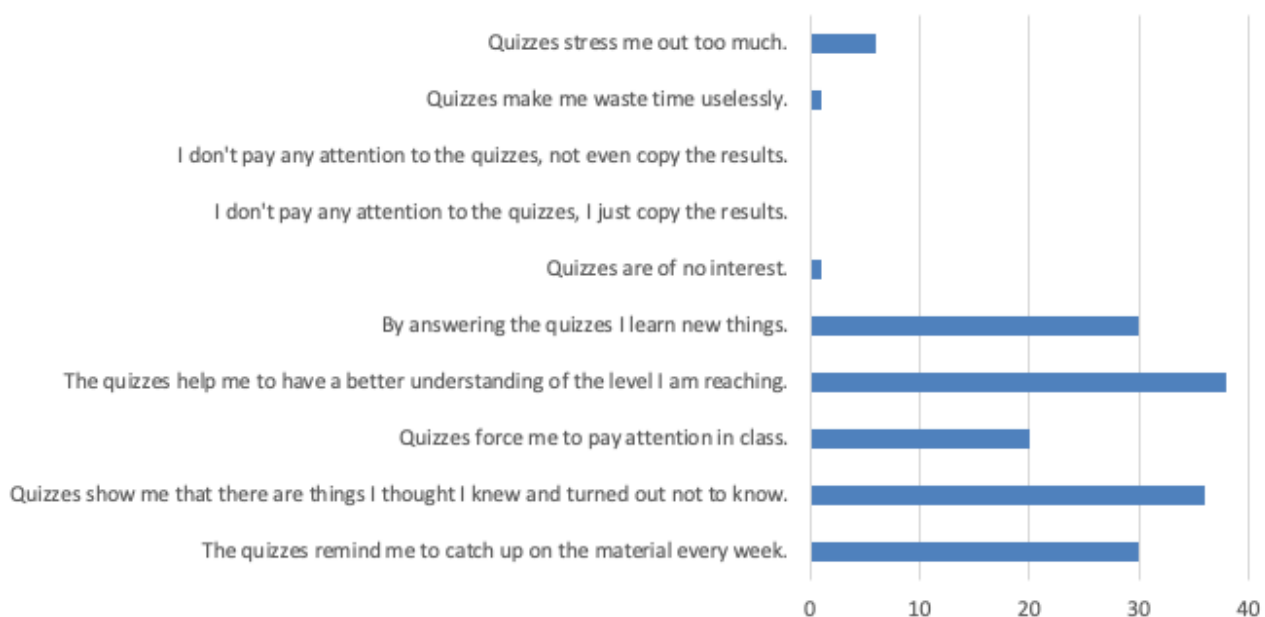
Graphic 3: Answers to the question "If there were no quizzes, do you think your grade would be different?"

About " If the quizzes didn't exist it would have been: more or less attentive in class" (Graphic 4), 18 think that without quizzes they would be less attentive in class, 28 think that would have the same attention and 1 didn't answer. Thus 38% believe that it makes them be more attentive (there are those who would already be attentive anyway, but, in principle, these are not counted).



Graphic 4: Answers to the question " If the quizzes didn't exist it would have been:"

About the next questions in **Graphic 5**, the number of respondents were (from top to bottom) 6, 1, 0, 0, 1, 30, 38, 20, 36, 30. In short, students believe that quizzes make them learn new things, study more, keep up with their studies, pay more attention, and be aware of the level they are reaching. Six students say that it gives them too much stress.



Graphic 5: Answers to the question " Please indicate ALL statements with which you agree:"

The open question of the survey was: "What do you like/dislike about quizzes?" we obtained 11 responses, all positive, reinforcing that it helps them to test whether they understand the material with basic exercises, also indicating that it forces them to pay attention in class and helps them learn more.

In an Informal Conversational Interview (Cohen, 2007) qualitative data was collected: the feedback of the two teachers of the course about this pedagogical practice. The teacher (who is the researcher) considers that the quizzes were a positive strategy. They made the students pay more attention in class, whenever she said "next comes a quiz", the students studied more quietly and more attentively. It was interesting, that in one of the classes, when the quiz was launched, the students were all working hard, whether at the beginning of the year or until the end. In the other class, there were some who were disinterested. She believes that some students felt some stress, via that some were very concentrated and asked straight away if they didn't know how to solve a part and it was clear that they were anxious. Although there was no reason for that, because if the answer wasn't correct at the beginning, they were allowed to change it and there was never a lack of time: the teacher opened the

test and only moved on to the next subject if almost everyone had already answered, and even let it open it until a bit after the end of the class. The teacher felt that it is time consuming, and sometimes is difficult to leave time for students to answer it.

The other teacher stated that quizzes are very important because they encourage all students to work and not leave studying until the end. He felt that they were important, because in his classes all the students worked when a quiz was launched, except for two students, who had a lot of difficulties, who pretended [note the pressure that quizzes generate] that they were solving it, and then ended up not handing it in. The teacher indicates that the time consumed by quizzes can be a problem, suggests to make shorter quizzes and/or fewer quizzes and that some might be done at home. Due to lack of time, he tried leaving some quizzes to finish at home but there were less students responding.

As discussion, first be aware that the surveys were automatically anonymous, meaning there was no pressure for students to respond positively to the survey, despite the researcher being their teacher. Student's participations rate in quizzes was very high with 72% of students obtaining 15 or more average values. And 41% over 19, that is, with almost all quizzes answered with full marks.

In the responses to the survey, an important result was that nearly all students find quizzes useful, 62% consider that the quizzes helped them to get a better grade, and 38% refer that were more attentive in class due to the quizzes. It should be noted that 6 students consider that the quizzes cause them a lot of stress. Students' opinion is that quizzes made them to learn new things, help them to have a better understanding of the level that they are reaching, make them pay more attention, and remind them to catch up on the subject.

Teachers also consider quizzes to be an effective way to make students more attentive in concordance with Nadeem & Al Falig (2020), to have a moment where they all work hard, and where they receive immediate feedback, again in concordance with literature (Booth,2012). In the future, given that quizzes take up a lot of class time, the intention is to move towards shorter questions or fewer quizzes.

Conclusions and future work

In order to create moments of active learning that at the same time provided immediate feedback to students, 31 online surprise quizzes were administered in class, in Moodle, around one per class, in a Calculus course to 112 students. Student participation in these quizzes was very high, answering almost all quizzes, with almost everything correct. In an anonymous online questionnaire with a very significant number of responses, student feedback was that almost everyone considered the quizzes to be useful. That makes them work harder, learn more and be more attentive. And that allows them to receive feedback and become more aware of the level they are reaching. It also makes them to be always updated.

Teachers also consider that quizzes are useful, make students more attentive and that quizzes also allow students to receive more constructive feedback as they can repeat until the result is correct. Due to the lack of class time, in the future we will have fewer quizzes or quicker quizzes to answer. Our findings are in line with literature: quizzes make students more attentive (Nadeem & Al Falig, 2020), and give immediate feedback which is positive for students (Booth,2012).

In short, given the high participation rate, the positive rating of the students and the encouraging reflection of the teachers, quizzes are undoubtedly a pedagogical strategy to maintain.

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