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Formative vs Summative Quizzes as Regular Feedback on Moodle in Computer Science Courses: Which do Students Prefer?

Natalia Nehring and Simon Dacey

Abstract

Deferred feedback on summative assessments can demotivate students and affect their overall learning performance, and it can change their study routines. The aim of this study is to compare and analyse students' perceptions about summative and formative regular feedback: whether they are better motivated by being given marks, or by regular feedback without any marks. All participants were students from a Bachelor of Computer Science (BCS) degree at a New Zealand tertiary institute. Three courses were selected across three different levels of the BCS, and the sample group included 272 students from five different semesters. Summative (with marks) and formative (with feedback only) weekly quizzes were introduced in 2017, with the aim of providing early, regular feedback to students. Participants in the study were divided into two groups: students who were doing formative, and those who were doing summative quizzes.

In each group, the majority of students indicated that they were happy and positive about getting regular feedback in the form of quizzes, and they appreciated the quiz questions and time spent as a way to adjust and enhance their learning. There was no real difference in students' subjective evaluations and individual perceptions between those who had summative and those who had formative quizzes. The existence of quizzes, and the results, were important for students as weekly feedback and it didn't matter whether marks were attached to these weekly feedback activities or not. More studies are needed to determine what type of questions could better influence students' learning outcomes.

Introduction

Student success and meeting learning outcomes are the main focus for tertiary providers. One way of providing support or scaffolding during a course of study is to use features on existing learning systems, like Moodle. The need for scaffolding is especially important for first-year students. The main aim is to establish effective study routines, which should encourage students to work regularly and independently. According to Haigh (2007), students' rating of quizzes against other course components shows that quizzes are the most highly valued element of the assessed course work. In interviews carried out in a study by Zainuddin et al. (2020), students claimed that they felt more engaged in learning by participating in quizzes. Students described their emotions as fun, enjoyment, interest, enthusiasm and curiosity.

A student's motivation is often correlated to their learning outcomes; a student with high achievement usually has a high motivation compared to others (Sulisworo et al., 2016). The length of a semester at the tertiary institute where this study was carried out is 15 weeks. The majority of the institute's computer courses have three summative assessments. The first summative assessments take place after five or six weeks of learning, the second summative assessments happen in Weeks 10 or 11 and the final assessment, usually an exam, takes place at the end of the semester. After each assessment there can be up to two weeks' delay before students get any feedback (Nehring et al., 2017). This can affect a student's ability to establish the required base knowledge and master essentials skills for the course, and ineffective study habits may be established. A student's motivation may be reduced as a result of late feedback (Auvinen et al., 2015). A number of studies have reported the increased use of learning management systems (LMSs), particularly Moodle, an open-source learning platform, as interactive learning tools (Kotzer & Elran, 2012) that provide effective learning environments (Ghosh et al., 2019; Luk et al., 2018). LMSs are highly popular (Conde et al., 2014), and Moodle has been reported as a safe, fit-for-purpose and fit-for-use space for users to design online courses (Adesemowo et al., 2016). This open-source platform allows students to engage in a variety of collaborative activities, with additional support from Moodle's various plugins. Studies have found that Moodle's collaborative learning environment improves student learning outcomes and student satisfaction, and provides scaffolding that is flexible for different types of learners (Smith, 2016; Paechter et al., 2010). A number of studies have investigated using routine quizzes as a way of providing regular feedback and as a way to support students during course delivery. The self-assessment works as an indicator that a student is on the right track, and keeps a student's motivation high towards study (Bälter et al., 2013; Kenis, 2011). Some research has reported that students' results improved after the introduction of quizzes as a form of regular weekly feedback (Bälter et al., 2013; Nehring et al., 2017; Martins, 2018). Features of LMSs, such as immediate feedback, are used to provide formative assessments, and Olson and McDonald's 2004 study reports they have improved students' results in summative examinations. Martins' 2018 study

results show that 70% of students stated that the existence of quizzes helped them to achieve a better grade. The same research suggests that quizzes are a useful tool to improve students' learning outcomes, and the author makes a recommendation to use quizzes as a tool to support teaching.

This paper seeks to answer the following research questions: What are students' perceptions about Moodle quizzes? Do students take summative quizzes more seriously than they do formative quizzes? The study engaged 272 participants, who were enrolled in the Bachelor of Computer Science (BCS) degree at a New Zealand tertiary institute. Participants were selected from Levels 5, 6 and 7. Table 1 shows student numbers for different courses and across different semesters. Summative weekly quizzes were introduced on the course Introduction to Database, which is a Level 5 compulsory course and is offered every semester. Formative weekly quizzes were introduced on two courses, Internet and Webpage Development (an elective Level 6 course) and Testing and Quality Assurance Management (an elective Level 7 course). The overall length of all three courses is 16 weeks.

Table 1. Number of participants for summative and formative quizzes.

Course/Level	Quiz type	Duration (minutes)	2017 s1	2017 s2	2018 s1	2018 s2	2018 s1
Introduction to Database/ Level 5	Summative	20	43	33	34	27	23
Internet and Webpage Development/Level 6	Formative	10 + 10	NA	NA	28	21	16
Testing and Quality Assurance Management/Level 7	Formative	20	19	NA	10	18	NA

Hypothesis

Our hypothesis was that summative quizzes would be considered more important to students than formative quizzes, as students get marks for summative quizzes. For the summative quizzes, a weighting of 10% of the total course grade was allocated. This 10% corresponded to 10 Moodle quizzes, with each quiz worth 1%. Our hypothesis and experience suggested that allocating a small percentage of the total grade to summative quizzes should encourage students to spend more time on study, and this should lead to better outcomes. Formative quizzes should be taken more lightly by students, as there would be less concern about the effect of quiz results on overall marks. Another hypothesis was that regular feedback could improve both the students' study habits and their understanding of the course.

Method

This study used a mixed-methods design and collected both quantitative and qualitative data concurrently over the length of the five semesters. On each course, weekly online quizzes were organised (Woit, 2003). Woit's study (2003) included 12 online quizzes (one per week) as well as a final online exam. Laboratory exercises were voluntary; however, at the end of each week, portions of the laboratory exercises for that week were selected for an online quiz. However, our study, while using weekly online quizzes, did not include a high-stakes (high weighting) online summative assessment. On one course low-stakes weekly online summative quizzes were used, and on another course weekly online formative quizzes were used. Participants (272 students) were split into two categories. In the first category were students (112) who participated in formative quizzes that didn't contribute to any summative mark for the course. Table 1 shows the number of students in different semesters for each course (Testing and Quality Assurance Management, and Internet and Webpage Development) and that the data was gathered in three semesters for each course. The course Testing and Quality Assurance Management had a weekly quiz of 20 minutes' duration. The second course, Internet and Webpage Development, had two weekly quizzes of ten minutes' duration, one at the beginning of a three-hour session and one at the end of the session. The first quiz had two questions only, which were based on the previous week's material. The second quiz had two question that included programming code, which were related to course material as well. The students in the second category (160) did summative quizzes and studied the course Introduction to Database, Level 5. Data for the second category was collected for five semesters. These students had ten summative quizzes during the semester, each of 20 minutes' duration, with 1% of course marks attached to each quiz.

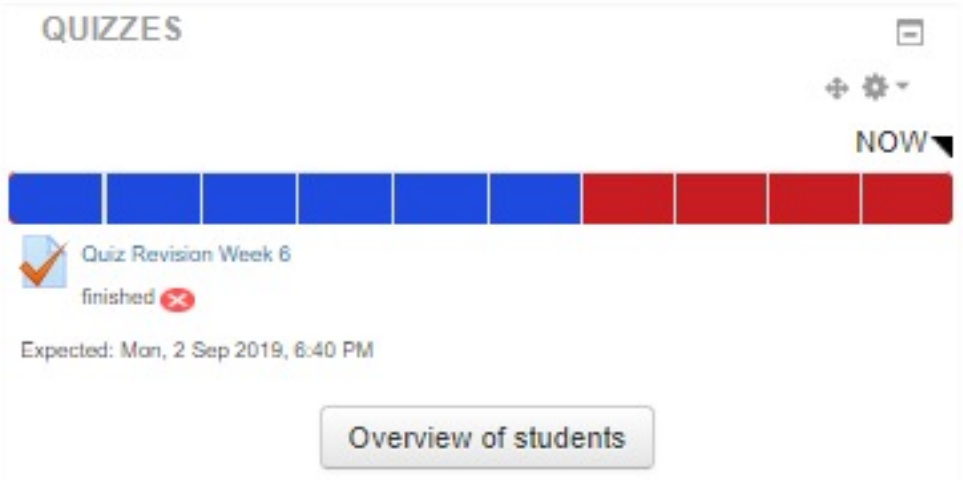


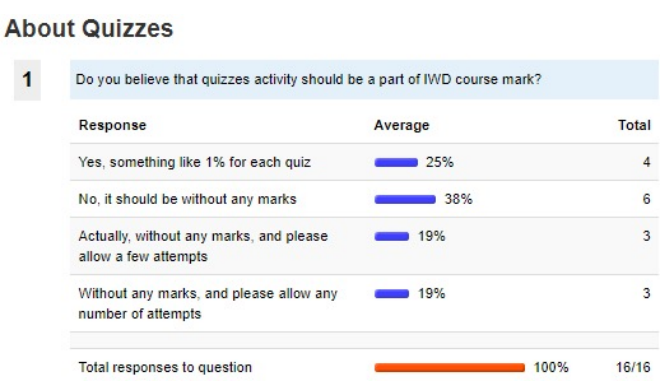
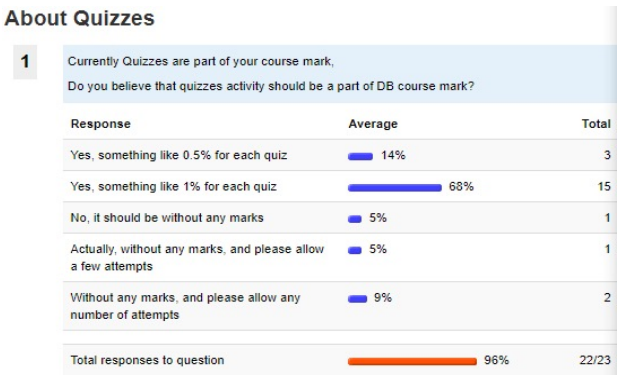
Figure 1. The progress bar on Moodle is a way to indicate Student Quiz progress through the semester.

For the formative category, for each selected course a bank of questions for weekly quizzes was developed using Moodle, the open-source learning management system. Regular formative quizzes become weekly casual assessments and immediate feedback for each course learner. For the summative category, a previously developed bank of questions was used for that course, Introduction to Database (Nehring et al., 2017).

Each quiz consisted of different questions related to the previous week's materials, meaning each week students were doing a quiz as a revision. Each quiz allowed only one attempt for each student. The scores were shown to students after the completion of each quiz. There were six to ten questions in each quiz, in both summative and formative categories. The quizzes were set on Moodle using the quiz feature, and the question types were selected from those provided by Moodle. We used:

- Multiple choice
- True/False
- Matching
- Drag and drop into text
- Select missing words

Table 2. Students' perception about marks for quizzes.

Formative Quiz (Data from IWD, 2019 s2)	Summative Quiz (Data from Introduction to DB) 2019 s2
	

This choice was based on the ability to get immediate feedback on Moodle, without lecturer or marker involvement. For each course, all quizzes were set as 'tracked completion' activities, and each student was able to see their progress during semester on a progress bar (Figure 1).

A subjective evaluation survey was done at the end of each semester, in week 12, after students had completed the majority of course quizzes. Data from each semester for each course was collected, and grouped by the two categories: formative and summative. Questions about the user experience were developed, three of which were taken from Bälter et al.'s research (2013). The main set of survey questions about the user experience was taken from our previous research (Table 3), which investigated the effect of summative quizzes on student performance (Nehring et al., 2017). Some

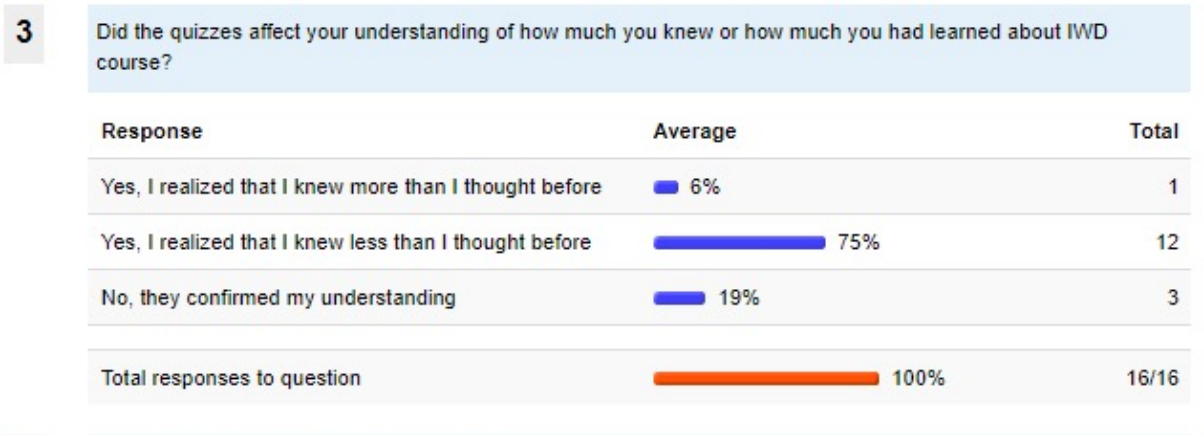
additional questions were added later, as shown in Table 2. For each category of quiz, final results were calculated for each question. Comparisons were conducted between formative and summative quizzes. The responses to each question were calculated as a percentage and a numeric value. The results are displayed as percentages, in order to compare the groups comprised of different numbers of students: the formative group is comprised of 112 students, and the summative group of 160 students. To compare the different group responses, one t-test, two-sample assuming equal variances, was run on the data to find whether there was a statistical significance. T-tests have been used on data related to online quizzes in studies such as Self-Assessment Quiz Taking Behaviour Analysis in an Online Course (Ozarslan & Ozan, 2016) and Learners' Experience Towards e-Assessment Tools: A Comparative Study on Virtual Reality and Moodle Quiz (Al-Azawei et al., 2019).

Students' opinions about marks allocated for quizzes differed depending on which group they belonged to (Table 2). Students who were doing formative quizzes believed more strongly (38%) that the quizzes should have no marks attached to them. On other hand, students who were doing summative quizzes strongly believed (82%) that marks should be assigned to the quizzes, with 68% suggesting that 1% of the course mark be assigned for each quiz and 14% suggesting assigning 0.5% of the course mark for each quiz (Table 2).

Results and discussion

Analysis of data across number of semesters demonstrates that there is not really a big difference in students' answers in the two categories of formative and summative quizzes. Questions about students' attitudes get almost the same scores in each category, or similar distributions. For example, students' answers to the question "Do you believe that weekly quizzes affect your study habits?" (from 1 to 10, where 10 is highest) gave an average of 6.9 for the formative category and 7.1 for the summative category. However, for stress levels when doing quizzes, students reported a slightly higher score difference of 0.8: in the formative category they gave an average score of 4.9 (from 1 to 10, where 10 is highest) and in the summative category they gave an average score of 5.7. This result correlates to results reported in a study by Pitt et al. (2018) that stress levels during semester were between 5 and 6 on 10-point scale (where 10 is highest).

The running of the t-test on the data that yielded a two-sample assuming equal variances t- value of 0.053 has confirmed that there was no significant difference in students' responses between the categories of formative and summative quizzes for the question "Were your study habits affected by your quiz results?" In the formative category 55% of students, and in the summative category 55.4%, stated that they studied harder. For the question "Were your study habits affected by the existence of the quizzes?" the answer "Yes, I study harder" was chosen by 55.3% of students in the formative category and 47.8% of students in the summative category. Data



3 Did the quizzes affect your understanding of how much you knew or how much you had learned about IWD course?

Response	Average	Total
Yes, I realized that I knew more than I thought before	6%	1
Yes, I realized that I knew less than I thought before	75%	12
No, they confirmed my understanding	19%	3
Total responses to question	100%	16/16

Figure 2. Response to the question "Did the quizzes affect your understanding of how much you knew or how much you had learned about the IWD course?" regarding formative quizzes in Semester 2, 2019.

from the course Internet and Webpage Development, Semester 2, 2019 (Figure 2), shows that, by doing formative quizzes, 75% of students realised that they knew less than they thought they did. This result implies that the existence of formative quizzes provides a good effect on students, in that regular feedback helps them to understand their level of learning, which is in line with the findings of Glazer (2014), who states that formative assessment has a central role in enhancing learning.

Our hypothesis, that summative quizzes would be considered more important to students than formative quizzes, is seen to be incorrect. The data results in the two different categories demonstrate that formative quizzes have the same effect on students as summative quizzes. Both formative and summative quizzes can work as a regulation mechanism, and can provide regular feedback. Regular and immediate feedback is the most important factor in quizzes, and it is appreciated by our students. It is useful for a big cohort of students, as the lecturer is only involved in the quiz design, and the quiz marking is done automatically by the Moodle system. Feedback on Moodle quizzes is immediately available to the students.

Students' comments for formative quizzes included: "good practice," "the quizzes were good at reinforcing confidence (progress made so far)." Students made similar comments for summative quizzes: "Useful, motivate students to study, I am regret for myself because I was supposed to get higher marks in early quiz," "I really enjoyed the quizzes and was fun to do them as well as beneficial for course understanding." Overall, the students' confidence is boosted by getting regular feedback from online formative quizzes. This observation agrees with the findings of Cassady and Gridley (2005), who have stated their results support the integration of online practice tests to help students prepare for course exams and also reveal that secure web-based testing can aid undergraduate instruction through improved student confidence. Woit (2003) notes that a majority of students report that online tests motivate them not to cheat on marked laboratory assignments, and motivate them to attend class and laboratory sessions. We found from our results that, in line with other studies (Woit, 2003; Bälter et al., 2013; Cassady & Gridley, 2005), either formative or summative online quizzes are a good tool to motivate students to perform better in a more heavily weighted summative assessment.

Table 3. The effect of doing formative quizzes vs summative, main set of question.

	Quiz type	**Formative**	**Summative**
	Number of student responses	112	160
1	*Do you believe that weekly quizzes affect your study habits?*		
	Agree from 1 to 10, 10 is strongly agree.	6.9	7.1
2	*Did the quizzes affect your understanding of how much you knew or how much you had learned about your course?*		
	Yes, I realised that I knew more than I thought before	22.5%	32.8%
	Yes, I realised that I knew less than I thought before	52.2%	42.2%
	No, they confirmed my understanding	17.5%	14.8%
	No, they did not show what I had learned	6.0%	5.5%
	I don't know [This point was added later]	7.3%	5.6%
3	*Did you find it stressful to do the quizzes?*		
	Agree from 1 to 10, 10 is strongly agree.	4.9	5.7
4	*Were your study habits affected by the existence of the quizzes?*		
	Yes, I studied harder	55.3%	47.8%
	Yes, I studied less	10.8%	10.8%
	No, I would have studied just as much/little	25.6%	30.6%
	I did not study more, but earlier	6.3%	3.7%
	I don't know	7.2%	8.6%
5	*Were your study habits affected by your quiz results?*		
	Yes, I studied harder	55%	55.4%
	Yes, I studied less	7%	7.6%
	No, I would have studied just as much/little	24.5%	31.6%
	I did not study more, but earlier	5%	1%
	I don't know	11.5%	4%
6	*Did you consider the questions to be suitable for you?*		
	Agree from 1 to 10, 10 is strongly agree.	7.1	7.2
7	*Do you think that the quizzes were an efficient use of your time?*		
	Agree from 1 to 10, 10 is strongly agree.	7.4	7.2
8	*How many questions should be on the quiz (which should last 20 minutes)?*		
	(Enter number)	8.2	8.4
9	*How many answers are optimal for the multi-choice question?*		
	Fewer than 4	24%	16.8%
	4	50.2%	62.6%
	5	19.7%	14%
	6 or more	9.5%	8.5%

An additional benefit is that Moodle quiz data is a reliable electronic attendance record for each student, which is more accurate than a paper-based attendance list. It is important for each department to keep attendance records for international students, as mandatory attendance is a student visa condition.

Conclusions and future research

In this paper, we investigated the effect of providing regular feedback on students' academic achievement in three courses of a Bachelor of Computer Science degree, at Levels 5, 6 and 7. Subjective evaluation in the form of Moodle questionnaires showed that the majority of students liked getting regular feedback in the form of quizzes and found it valuable for their learning. From our observations it appears that summative quizzes are more suited to Level 5 students and help them to structure their study. Level 6 and 7 students tend to be more self-motivated and feedback from formative quizzes helps them to adjust their study for specific topics. One limitation of this study is that the formative and summative quiz categories came from different courses. Students at Level 5 were given summative quizzes and students at Levels 6 and 7 were given formative quizzes.

More research is needed to examine the effectiveness of weekly quizzes on students' performance throughout the entire semester at different levels. In particular, it would be interesting to carry out this study with a group of students who are simultaneously taking a course with summative quizzes and a course (at the same level) with formative quizzes. Further study is needed to confirm the hypotheses that summative quizzes are more suited to Level 5 students and formative quizzes are more helpful to Level 6 and 7 students. Another possible path of research would be to look more closely at students' emotional involvement and motivation with regards to both formative quizzes and summative quizzes.

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