
Effectiveness of self-assessment quizzes as a learning tool

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Abstract: *To enhance the students' learning experience, self-assessment formative quizzes are being incorporated into the curriculum by several lecturers. With the technological developments in web-based delivery, online quizzes may be an effective learning tool, especially when courses are offered via external mode of study. Among the several advantages of providing online quizzes, the most attractive feature is providing the correct answer and appropriate feedback immediately after students attempt a quiz. This paper evaluates the overall performance of students in two engineering courses where self-assessment quizzes were made available through the e-learning system. As formative assessment, it was noted that the frequent attempts by students tend to cluster near the final examination period, however, a few students attempted them as soon as they were released. The results showed there is a strong correlation between students who attempt the quizzes and their overall student performance assessed by final grades. This paper will further discuss the important aspects that need to be considered when developing well formulated quizzes for technical courses and thereby maximising their potential as an effective learning tool.*

Introduction

Formative assessments in the form of online quizzes are currently being introduced by several lecturers in order to enhance the students' learning experience and student engagement. Woit and Mason (2000) experimented the use of weekly online quizzes to facilitate the student learning especially to resolve a problem with weaker students under-performing in computer programming courses. The online quizzes have been adopted by Aziz (2003) to provide flexible assess to self-paced interactive study materials and to self-assess the progress of study for on-campus teaching. While the online or paper-based quizzes are effective in on-campus delivery as reported in Aziz (2003), they become very valuable tool and imperative especially when the courses are offered in dual-mode delivery (on-campus and external) in a flexible online environment as offered at University of Southern Queensland (USQ). At USQ, we have on average 20% on-campus and 80% external students who learn through online resources. While the on-campus students are mainly school leavers and take advantage of face-to-face delivery of the courses, the externals are mature age working students who mainly rely on the study materials and other resources offered to them in online learning management system.

Online quizzes are considered to be effective learning tools as formative assessments especially to those students who choose to learn through independent mode of study as they can give instantaneous feedback regarding their progress in understanding the key-concepts. Are these formative assessments increase the students' overall performance in their summative assessment where students are required to demonstrate their understanding through assignments and exams? Kibble (2007) reported that students who elected to use online quizzes performed better in summative examinations. However, a study conducted by Peat and Franklin (2003) reported there is no correlation between the performance in formative quizzes and the subsequent performance on summative assessments for inexperienced biology students, although a positive effect was established later in the program (Peat et al., 2005). In this study, we evaluate the overall performance of the students in two engineering courses where self-assessment quizzes were made available as formative assessments through Moodle learning management system. The two courses were selected as they used formative quizzes but with different objectives. We further investigate and report the students' trends in attempting the quizzes. The challenges in delivering the quizzes in flexible environment and increasing the student participation are also discussed.

Methodology

Two courses have been selected as case studies where online self-assessment quizzes have been introduced as part of formative assessment scheme in these courses. The two courses used the online quizzes to enhance the student performance in different summative assessments.

Case study 1 – Concrete structures (CIV3506)

Concrete structures (CIV3506) is a design based course for bachelor of engineering program (civil engineering major) taught in their 3rd year of study. In this course, 14 quizzes were developed and progressively released throughout the semester. These quizzes were developed in such a way to cover all the topics in the course to reinforce the key concepts in each topic. Table 1 shows the assessment scheme for this course, where the summative assessment consists of two assignments (25% weight) and an exam (75% weight). The first assignment gauges the students' knowledge on reinforced concrete beam design while the second assignment on slab, column and prestressed concrete design. Due to a university wide policy on having two hour examination, the exam is designed to assess the understanding of critical objectives in specific topics i.e., beam, column and prestress. The assessment scheme is designed in such a way that the quizzes are meant to facilitate fundamental concept learning, while the assignments check a deeper understanding of the design of structural elements and the exam is to confirm their understanding on critical objectives.

Table 1: Assessment scheme for course CIV3506

Major topics	Quizzes	Assignment (25%)	Exam (75%)
Intro, material properties	1-3	Assignment 1 (10%)	2 hour open exam (75%) a) Beam design (37.5%) b) Column (20%) c) Prestress (17.5%)
Beam design (flexure)	4-6		
Beam (shear, deflection)	7-9		
Slab	10	Assignment 2 (15%)	
Column (short, slender)	11-12		
Prestress (basics, losses)	13-14		

Case study 2 – Public health engineering (ENV4203)

Public health engineering (ENV4203) is a core course for those students who are majoring in Environmental and Civil Engineering at undergraduate level. It is also a course offered in postgraduate programs such as graduate certificate in engineering, master of engineering technology and master of engineering and science within the Faculty. The prerequisite for this course is Hydraulics 1, which assists students in understanding the required design concepts presented in specific modules of this course. Public health engineering requires an interdisciplinary knowledge and experience encompassing chemistry and microbiology, which dictate the water quality issues. The students enrolled in this course need to grasp the required concepts in these areas as applied in water and wastewater treatment to meet the course objectives successfully. Those students without the chemistry/microbiological background have difficulties in understanding these concepts presented in this course. A new and innovative teaching approach was required to facilitate the students' learning of these unfamiliar materials.

Table 2: Assessment chart for course ENV4203

Major topics	Quiz no.	Assignment (20%)	Restricted exam (80%)		
			Quantitative	Qualitative	MCQ
Water/wastewater treatment	4,5	-	30%	10%	5%
Design of water supply scheme	-	Assignment 1 (10%)	14% (in either of topics)	6%	
Design of sewer network	-	Assignment 2 (10%)			
Miscellaneous*	1-5	-	-		15%

* Miscellaneous include appurtenances, sludge treatment, water chemistry, microbiology etc.

Therefore, in this course, quizzes were developed to motivate students to learn these unfamiliar materials related to chemistry and microbiology as well as the theoretical concepts presented in the course. As shown in Table 2, assignment scheme consist of two assignments (20%) and an exam (80%). The assignments gauge the students' deeper understanding of two modules on design of water supply scheme and sewer network. Furthermore, 55% of the exam consists of quantitative questions while 45% qualitative questions in the form of short answers and multiple choice questions (MCQ). The quizzes, therefore are designed to facilitate the students to address the qualitative questions and MCQ.

Quiz design

In CIV3506, most of the quizzes were designed as quantitative questions, while a few questions were qualitative. The answers to the quizzes include the right answer, but more importantly distracters as well. In modules that covered design of elements (such as beam or column), The questions in the quiz were designed in such a way that lead them through grasping the steps involved in the design of concrete structures. Hence, a wrong answer in the early steps could result in getting all the other questions wrong with consequent erroneous design. Figure 1 shows a typical quiz question on materials properties. Though this question would appear to be very simple, unless the students understand the behavior of steel yielding, they are likely get this question wrong in the first attempt. Immediate general feedback is given after the attempt of the quiz and in the case of distracters, more specific feedback is also provided why the selection is wrong.

What is the stress in N type steel when the strain is 0.005 ?
Choose one answer.

- a. 250 MPa ✗
- b. 400 MPa ✗
- c. 500 MPa ✓
- d. 1000 MPa ✗
- e. 100 MPa ✗

The equation $\text{Stress} = \text{Strain} \times E$ is only valid in elastic region, not after yield strain (or plastic region).

Feedback:
When the strain is $>$ yield strain, then the stress is always equal to f_{sy} . This is because, the maximum stress that steel can take is f_{sy} . Even if the strain is very large, the stress cannot increase beyond f_{sy} .

Figure 1: Typical question in CIV3506

In ENV4203, most of the questions in the quizzes were designed as qualitative with a few as quantitative to gauge the students' understanding on those areas such as chemistry and microbiology that civil and environmental engineering students are not familiar with. While the answers include the right answer, each wrong answer represents a common misconception to mimic student thinking and eliminate easy guessing.

The potential contaminants that can be introduced to the water ways through mining activities are
Choose one answer.

- a. sediments, acid and heavy metals
- b. acid, heavy metals and pathogens
- c. sediments, fats and nutrients
- d. heavy metals, sediments and nutrients

Figure 2: Typical question in ENV4203

Quiz delivery

The developed quizzes in both courses were delivered via the learning management system Moodle, which is an open-source software. Quizzes were released progressively throughout the semester. In Moodle, as soon as the students attempted the quiz, the correct answers and feedback could be released. In addition, Moodle also gives automatic scoring and reporting facilities that can be explored for evaluating the learning and teaching performances. In this case, reports can be generated on how

many times a student attempts the quizzes and when they attempt. In CIV3506, the students were given three attempts per quiz. In ENV4203, each quiz contained 10 questions, which were randomly selected from a question bank. The students were given unlimited attempts, and therefore they would get different sets of questions every time they try. The quizzes were progressively released throughout the semester in both courses.

Students' performance

Case study 1 –CIV3506

Reports were generated through Moodle for semester 1, 2009 offer in CIV3506. There were 77 students in this course, among whom 57 studied the course in external mode. The data reported includes both on-campus and external modes of study. Among the 14 quizzes released progressively, 21 students attempted more than 12 quizzes (27%), 11 students attempted 8-11 quizzes and 6 students attempted 4-7 quizzes. 39 students attempted less than 3 quizzes, which constitutes 50.6% of the class. Figure 3 summarises the variation of the percentage of students with their quiz attempts. Figure 4 gives the breakdown of the grades with the number of quizzes attempted. Table 3 summarises the number of students who attempted the quizzes and their corresponding grade distribution.

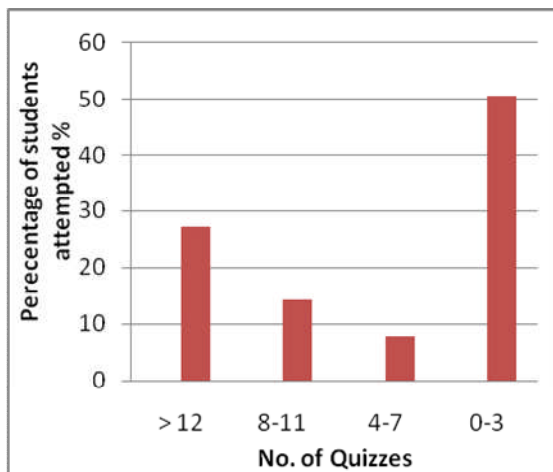


Figure 3: Percentage of students who attempted the quizzes

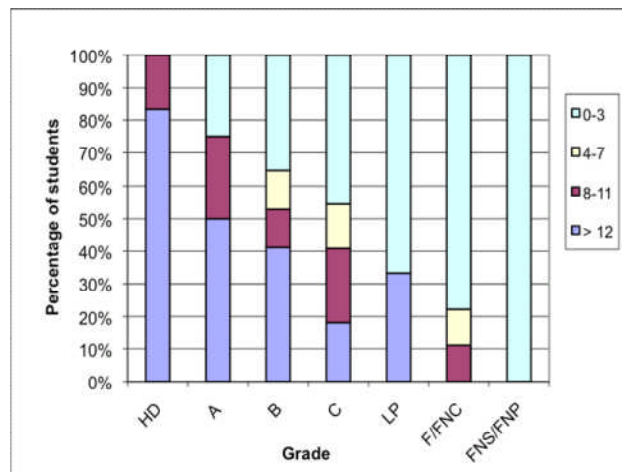


Figure 4: Grade distribution with number of attempts

Table 3: No of students who attempted quizzes and their corresponding grades in CIV3506

Grade/Attempt	HD	A	B	C	LP	F/FNC	FNS/FNP	Total
> 12	5	4	7	4	1	0	0	21
8-11	1	2	2	5	0	1	0	11
4-7	0	0	2	3	0	1	0	6
0-3	0	2	6	10	2	7	12	39
Total	6	8	17	22	3	9	12	77

Those who got high-distinction grade (HD) have attempted more than 11 quizzes. Among those who got distinction (A), 75% of them attempted more than 8 quizzes. 2 of them got A grade without attempting any quiz. These two were from on-campus cohort. Among those who got the Credit (B) grade, 9 students have attempted more than 8 quizzes, while 8 have attempted less than 7 quizzes. Among the 22 who got a pass grade (C), only 4 had attempted more than 12 quizzes. Among those who got Low passes (LP), only one attempted more than 12 quizzes. Among those who got the fail grades (F/FNC/FNS/FNP), 13 students did not attempt any quizzes, while 6 attempted only 1-3 quizzes. As shown in Figure 4, there is a gradual decrease in the overall performance when the quiz attempts have decreased. This shows the number of attempts in quizzes has a strong correlation to their overall performance.

The variation of the number of students who attempted the quizzes and total number of attempts for each quiz as the semester progressed is given in Figure 5. The first quiz was attempted by 47

students (61%), while this number has gradually decreased to 25 (32%) for the last quiz. It can be seen that the number of attempts peaked in the 2nd quiz and similar peaks could be observed for 4th, 10th and 13th quiz. These quizzes correspond to topics on material properties, rectangular beam design, short column design and basics of prestressed concrete. It can be also noted that students have attempted a quiz more than once. In average, the number of attempts per quiz is 1.5 per student, with a peak of 1.9 for quiz 4, which is on rectangular beam design. This shows that the students are selective in the topics and they tend to learn only the most essential topics in the course. The topics of beam design, column and prestress were assessed in the assignments as well as exam.

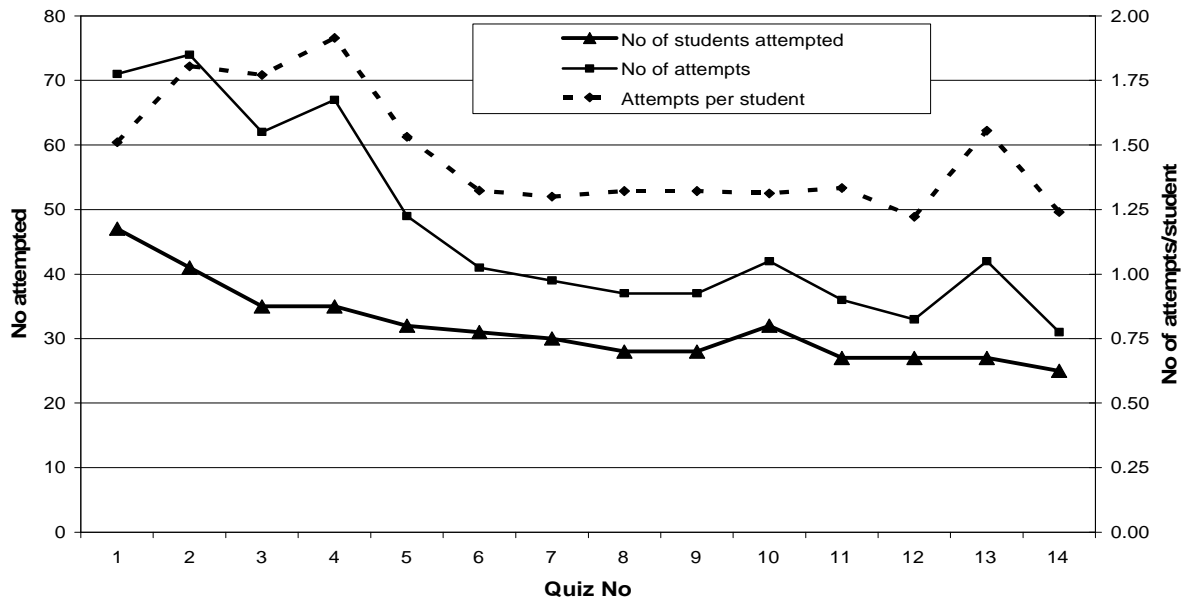


Figure 5: Progress on quizzes through semester in CIV3506

Case study 2 – ENV4203

In ENV4203, there were 68 students in the class, out of which 48 were enrolled in external mode. Among the 5 quizzes released, 16 students attempted all 5 quizzes, while 15 attempted 4 quizzes. 29 students (42%) did not attempt any quizzes. Figure 6 summarises the overall performance of students in the course with their quiz attempts. Figure 7 gives the breakdown of the performance in Q1 of exam (MCQ) with their quiz attempt. It should be noted that the two hour restricted exam had 5 questions, out of which students can attempt any 4. Hence, as summarised in Table 4 it can be noted 60 students attempted the MCQ section out of 65 students who sat the exam. This shows that 92% of the students had chosen to attempt the MCQ section, indicating that the students believe attempting the MCQ would result in better grades than other quantitative or qualitative questions.

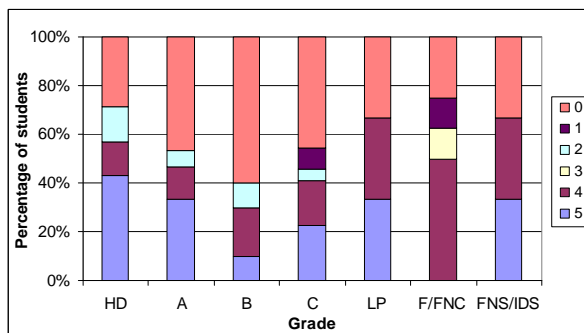


Figure 6: Overall performance and quiz attempts

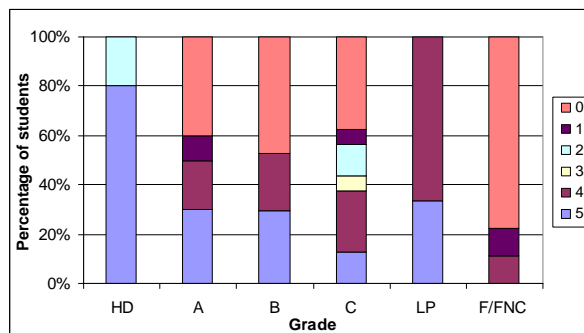


Figure 7: Grade in MCQ with quiz attempts

As can be seen from Figure 6, there is poor correlation with the overall grade for the course with the quiz attempts. This is because of the fact that the 5 quizzes were designed to facilitate the understanding of the qualitative aspects of ENV4203, and therefore they do not cover the overall course objectives. However, as seen from Figure 7, there is very good correlation between their

performance in the MCQ section and quiz attempt. Among those who got HD level marks in MCQ section, 80% of them have attempted all 5 quizzes. In the A and B level marks in MCQ, 50% of the students have attempted 4 or more quizzes. Among those who got the fail grades (less than 45%) only 1 student attempted 4 quizzes, while 7 had not attempted any quiz. This shows the number of quizzes attempted has a strong correlation to their performance in the MCQ section, which contributes to 25% of the total marks in the exam.

Table 4: No of students attempted quizzes and their performance in ENV4203

Grade/Attempt	HD	A	B	C	LP	F/FNC	FNS/FNP	Total
Overall grade performance								
5	3	5	1	5	1	-	1	16
4	1	2	2	4	1	4	1	15
3	-	-	-	-	-	1	-	1
2	1	1	1	1	-	-	-	4
1	-	-	-	2	-	1	-	3
0	2	7	6	10	1	2	1	29
Total	7	15	10	22	3	8	3	68
Performance in MCQ section								
5	4	3	5	2	1	-	n/a	15
4	-	2	4	4	2	1	n/a	13
3	-	-	-	1	-	-	n/a	1
2	1	-	-	2	-	-	n/a	3
1	-	1	-	1	-	1	n/a	3
0	-	4	8	6	-	7	n/a	25
Total	5	10	17	16	3	9	n/a	60

The variation of the number of students who attempted the quizzes and total number of attempts for each quiz is given in Figure 8. The first four quizzes were attempted by 33 students in average representing 49% of the enrolled students. The last quiz was attempted only by 29% of the class. This particular quiz covered the topic on fundamentals of wastewater measurements such as BOD (biochemical oxygen demand), COD (chemical oxygen demand) and organic measurements etc. Civil engineering students perceive this topic to be difficult while for environmental engineering major, this is an essential topic, which is evident from the lower number of attempts. However, it is interesting to note that among those who attempted the quizzes, they have attempted nearly 3 times in quizzes 3, 4 and 5 compared to only 2.6 attempts in quizzes 1 and 2.

Unlike CIV3506, in this course, the 10 questions are displayed in a quiz at a time from a question bank and the number of attempts was set to be unlimited. Hence, the more attempt they have, the higher the chances of getting new questions, that has resulted in higher number of attempts in ENV4203 compared to 1.5 attempt per quiz in CIV3506.

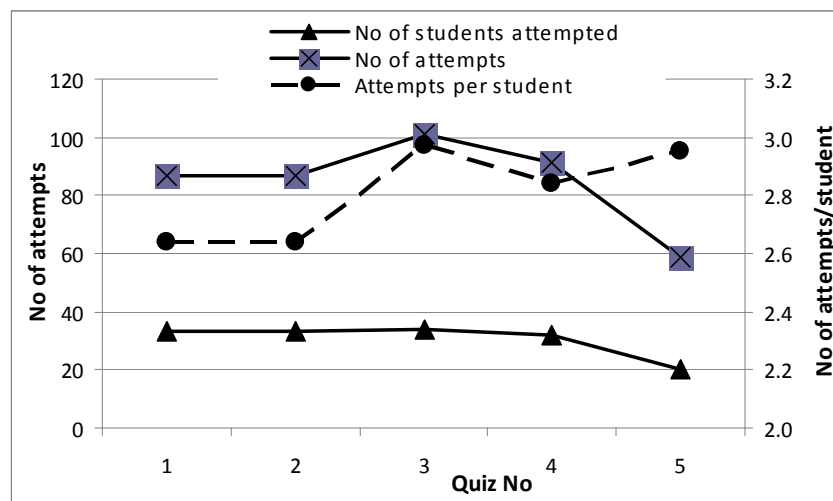


Figure 8: Attempts in quizzes in ENV4203

Discussion

Student participation

Quizzes were prepared and delivered through online learning management to provide additional support required by those students who learn through independent ways and to improve student interaction and engagement. However, it was noted that nearly 50% of the students did not attempt the quizzes in both courses. Kibble (2007) also found that the student participation was less in their formative assessment, and therefore he offered incentives in the form of course credit between 0.5% and 2% per quiz, that resulted in drastic increase in participation. The student feedback also reinstated this idea. However, while there may be advantages by making the quizzes summative and reward for students who attempt the quizzes regularly in their overall grades, there are some challenges in implementing this, especially in a flexible learning environment where 80% study on external mode.

The major challenges in making quizzes summative is that the quizzes will need to be time restricted to make sure the students have genuinely attempted and not cheated, especially with on campus students, who has opportunities to collaborate. However, this takes off the flexibility of learning among external students, who have work commitments and family responsibilities. If a flexible deadline is given for completing the quizzes, then the questions need to be drawn from a bank of questions, hence the chances of cheating is minimised. As such development of quizzes takes considerable time, the resource implications for the Faculty or staff involved need to be seriously considered. In addition, there are students who study externally from remote locations where access to internet is limited, which also needs to be taken into consideration.

We also noted that our students tend to follow a strategic approach to learning rather than a deep approach whereby they choose the type of quizzes that directly feed into the exams and assignments as in the case of CIV3506 and choose the quizzes of those modules where they can learn the concepts easily rather than venturing into some topics they perceive difficult as in ENV4203. In order to enhance the deep understanding of key-concepts of certain modules, instead of letting the students try the multiple choice questions developed by the teachers, it is possible to let the students prepare the quizzes that will have added benefits of student engagement and enhance deep-understanding of key concepts (Aravinthan, 2010). The *PeerWise* developed by Paul et al could be experimented to find out how it promotes the learning. (Paul et al., 2008). As 5 quizzes selected from over 100 questions have been trialled in ENV4203, the above approach could be ideally trialled in future years that can result in a data bank of questions to make it viable for a summative assessment.

Another observation that was made in CIV3506 is that several students tended to attempt the quizzes in the later part of the semester. For example, in CIV3506 it was noted among those who got C grades and attempted all the quizzes, 75% of them attempted in the last week before the exam period. In this particular course, the quizzes are meant to be assisting in understanding the basic concepts and in no way designed to resemble exam questions. Hence, it is important to encourage students throughout the semester to attempt the quizzes early to make the best use of them. However, in ENV4203, as the quizzes do resemble the MCQ section, even last minute attempt would increase a better performance.

Conclusions

In this paper, we evaluated the effectiveness of self assessment online quizzes as a tool for enhancing student performance. Two courses were selected as case studies where the quizzes were trialled with different objectives. In one course, 14 quizzes were trialled that encompassed all the topics in the course. In the other, 5 quizzes were trialled which directly related to the MCQ section of the exam. The following conclusions are made.

- There is a strong correlation to those who obtain a higher overall grade to the number of quizzes attempted in course CIV3506, which agrees with the previous findings (Peat et al., 2005).
- The correlation was poor in ENV4203 in the overall performance to the quizzes attempted. However, there was good correlation to those who attempted the quizzes and their performance in the MCQ section of the exam.
- Those who attempted the quizzes, attempted more than once in general and in ENV4203, the attempt rate was as high as 3 times in some quizzes. There was some evidence of selective learning of topics in both courses.

It is recommended that making such quizzes part of the summative assessment need further consideration depending on the overall course objectives and the assessment scheme.

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