



# Online Maths Low Stake Quizzes

**Faculty:** Engineering  
**Department:** Chemical Engineering  
**Module name:** Mathematics Fundamentals/Engineering Mathematics (CENG40007, CENG50007)  
**Degree:** Chemical Engineering  
**Level:** Undergraduate year 1 and 2  
**Approximate number of students:** ~150-160 in each year group  
**Weighting and credit:** 10%  
**Module type:** Compulsory  
**Module ECTS:** 10.0

## Insights colour key

Educational Developer

Inclusivity

Learning Designer

Registry

Careers

## Assessment overview

This is a flexible, learning focused quiz-based mathematics assessment for two maths modules in Chemical Engineering: Mathematical Fundamentals; and Engineering Mathematics. While there is a minimal amount of credit attached to the quizzes (10%) their purpose is formative, i.e. they are designed to help students learn maths concepts. Student learning is facilitated through a level of flexibility as to when to take the quiz, how long to spend on it, allowing unlimited number of attempts without any penalty and an option to work out a problem in a group.

The assessment is run 10 times throughout the academic year, covers approximately 10 questions each time and is linked to topics covered in the modules. To allow flexibility of access it is delivered online via maths aware software called WeBWork.

## Design decisions

### Rationale for the introduction of the formative assessment

In the past one of the problems that was identified by the teaching team was that students were rarely assessed. This meant that students did not learn at regular stages across the year but rather would leave solving all the problem sheets towards the end of term with summative deadlines approaching. Introducing regular assessment with some credit attached to it was thought to eliminate this problem and improve student engagement with learning.

There is a great level of flexibility embedded into the design. Firstly, the assessment can be done individually or as a group. Secondly, the assessment allows multiple attempts. Finally, there is a level of flexibility in terms of when the student takes the assessment. There is a period of time when the quiz is open and the students are welcome to take it at any time within this period and are welcome to spend as much time of the quiz as they wish. All of this is offered to put the emphasis on student learning rather than grades.

### Rationale for electronic delivery

The assessment is online to ensure that students are not disadvantaged if they cannot come onto campus and to allow more flexibility overall in terms of the time and the place they choose to take the assessment. The ease of marking, i.e. quizzes are graded automatically, also makes electronic delivery a more preferable choice.

### Question design

As the software used is maths aware and recognizes equations and equivalences the questions are designed to be short answer questions, where students 'fill-in the blanks' instead of MCQs (Multiple Choice Questions).

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Role: Teaching Fellow; Fellow of the Higher Education Academy



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In order to make the questions more conducive to student learning the majority of questions are broken down into steps. This means that the students need to answer each step rather than the whole question. The questions are aligned with learning outcomes for each of the sessions and build up the knowledge and skills tested later on and aligned with the learning outcomes of the module. Most questions have an option of providing a 'hint', which is additional information that can help students who are struggling to arrive at the correct solution.

## Rationale for the software used

The software was chosen for several reasons. The most important one relates to it being 'Maths aware', i.e. able to read maths equations and recognise equivalences in answers. This made questions designs and input of answers easier. Secondly, the software contained a library of 37000 questions that could be reused therefore made creation of the question banks easier. Finally, the software allows the students to preview their answer before submission which means that issues with incorrect input (such as lack of a comma or brackets) that could generate a wrong answer can be prevented.

## Fit with other assessments and the programme/module

This assessment fits in with other assessments on the module. For example, for The Mathematics Fundamentals module the assessment strategy consists of 80% final exam, 10% spring test and 10% is the quizzes. The questions are associated with topics covered in the two modules, to ensure comprehension of concepts. The formative assessments allow students to test their understanding topic by topic which feeds into what is assessed in the final exam albeit at a higher level. The purpose of this assessment is not so much to get the students ready for the exam in terms of practising similar types of questions but rather making sure that they understand the concepts and they can apply them in different contexts.

## Practicalities

### Assessment organisation and arrangements around delivery

The questions are randomized and personalised for each student but a level of collaboration is encouraged, not to just put the answer in but rather to collaborate on the methodology. Weighting attached to each question is relatively small so if a student wants to, they can skip a problematic question and move on to the next. Assessments are spread out throughout the term so when a topic ends students are given a deadline to complete the quizzes.

If a student is struggling and would appreciate some support, the software has an option of a 'hint' and 'email the teacher button' which notifies the tutor that the student would appreciate help.

## Preparing students for assessment

The idea of the formative is introduced at the start of the modules so the students are aware that they will be given quizzes after each of the topics commences.

Once a quiz is made available there is an introduction set that the students need to go through and only then the other sets will open. This allows them to practice.

## Marking arrangements

The software can automatically grade the students' responses and output a mark. While there is some credit attached to the assessment it is unconventional because it accepts multiple attempts that students are not penalised for. The assessment allows students to go through the trial and error process with an emphasis on student learning, meaning they can try and fail and learn from those failures in a relatively safe environment that is unlikely to majorly affect their final grade.

## Feedback arrangements

Students receive feedback in terms of an answer being correct or incorrect and marks attached to the correct answer, to enable them to get a sense of what went well and what didn't go as well during the assessment. If an answer is correct this is where the feedback ends. If an answer is incorrect there are several other feedback strategies utilised. For students who are really struggling, personalised feedback from the tutor can be provided. Finally, there are detailed step-by-step solutions provided after the



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deadline, so that students can see where they went wrong and what to improve in the future. Students tend to only access solutions for questions which they got incorrect.

## Advantages of the assessment type

- This type of regular developmental assessment, whether designed as low-weighted summative assessments with a mark or pass/fail or purely formative, encourages early and sustained student engagement. It also provides students with the practice and feedback necessary to build self-efficacy;
- Small credit attached to it incentivises students to do the assessment;
- The flexibility of the assessment is an advantage for both the staff and the students and allows for a more inclusive design;
- The flexibility with when to take the quiz and there is nothing to stop a student making multiple attempts to achieve the right answer. It would be unhelpful for a student who is very close (i.e. missing a few significant figures) to be penalised. This method enables students to have a second chance and reinforces the focus on learning;
- The students can discuss and collaborate with each other, which solidifies learning. This ability to discuss also strengthens peer support;
- The hints provided within the questions provide more of a scaffold to guide the student to the right answer, which further helps to facilitate learning;
- It is helpful that the instructor can see the student view and their past attempts to understand better at what point they got stuck. This allows for better support if needed;
- Seeing past attempts also provides an instructor with the insight to suggest a student does not need to spend so long trying multiple attempts;
- Autograding is definitely an advantage as it allows the team to shift the time that would be spent marking to supporting student learning;
- Using the software also allows access to statistics about each quiz allowing the team to identify students who are not performing well consistently or not engaging as expected. These students are then contacted by the tutor to figure out what the reason for disengagement or bad performance is and how they can be supported further;

- The method of assessment is also advantageous in the sense that it provides detailed workings of the questions after the deadline, so that students can see where they went wrong and what to improve in the future. There is also the added benefit of a personalised solution if students seek help from the tutor;

## Limitations of the assessment type

- There are order of magnitude limitations, which are difficult to autograde. When there is a lack of context to a student's answer, it is hard to know what the units are'
- Unfortunately, errors in questions sometimes occur but those can be eliminated with the next reiteration of the quiz so with time these will be eradicated completely;
- There is a danger that students might feel overwhelmed with the frequency of the quizzes especially when combined with other assessment deadlines. This can be daunting especially in the first year of study when the students have many assignments and deadlines. To avoid this the module lead coordinates and liaises with other instructors to make sure that deadlines do not overlap with other coursework. This is where the flexibility of when to take the quiz also plays an important part in ensuring students have enough space to approach the assessment;
- As is often the case with online platforms of this type, the tutor is not able to see the workings but rather sees the final answers that were put in. This makes it difficult to see where the student is struggling and that is the important piece of information if the focus of the assessment is helping students learn. This can be circumvented by including steps. This means that the students need to answer each step rather than the whole question. In this case it means breaking down a problem into multiple sections and that way if a student really wants the feedback on one aspect of the problem, for example their methodology, they can. This approach works well with more difficult questions but overall most of the question are divided into a few subsections so that the answers can be checked at different stages;
- There could be some issues with the software



recognising a blank answer that requires multiple input, as it could treat it as a list where the order might or might not matter so there is some further programming that needs to go into clarifying that;

### Advice for implementation

- The current frequency of tests (10 tests/academic year) is suitable because sometimes, given the intensity at which things get near the end of an academic term, it is hard for students to keep up. Hence it was deemed essential to control the spread of assessments. Taking this broader assessment view can prevent over-assessing and overloading students;
- Ensure that the assessment is suitable for the assigned problems;
- The aim of the assessment should be the acquisition of knowledge and concepts over testing. If it is too exam-oriented, it may put unnecessary stress on students;
- It's important to regularly reinforce that they are small weighted and that learning by working through them in a time-limited way is more important than the mark received;
- It's important to keep track of students' engagement with the assessment, which can show those who are not engaging with the problems. There may be different reasons for this (such as mitigating circumstances), but often students just forget the access code or forget the deadline;
- Students could also be encouraged to talk to their personal tutor about their approach and any struggles;

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- When choosing the software, assess the pros and cons in terms of pedagogical versus technological needs;
- It is always useful to draw on the wider faculty wide knowledge and experience of the Ed Tech team who can advise on the best software to suit your needs;
- Striking the right balance between offering support in the form of 'hints' and allowing students to rely too much on this support can be tricky. This can be done by only enabling a hint option after several attempts.
- Make students recognise the skills that such a flexible approach to assessment helps them develop that can be useful in a workplace – those include time management, decision making, negotiation and listening. This can be further facilitated by adding some reflective questions at the end of the quiz to trigger further thinking such as Why did you approach the quiz the way you did? How did it work? How could it work better? This is especially beneficial in cases, such as here, where a similar assessment is repeated over a period of time.
- Ensure that the way the quiz is presented on the screen takes into account inclusivity needs of students. This includes: avoiding times New Roman font that can be tricky to process, ensuring there is appropriate spacing between dense questions, ensuring that the question and all the options are visible on one page without the need to scroll, ensuring that submit and next buttons are sufficiently separated and finally making the text reader accessible if necessary.