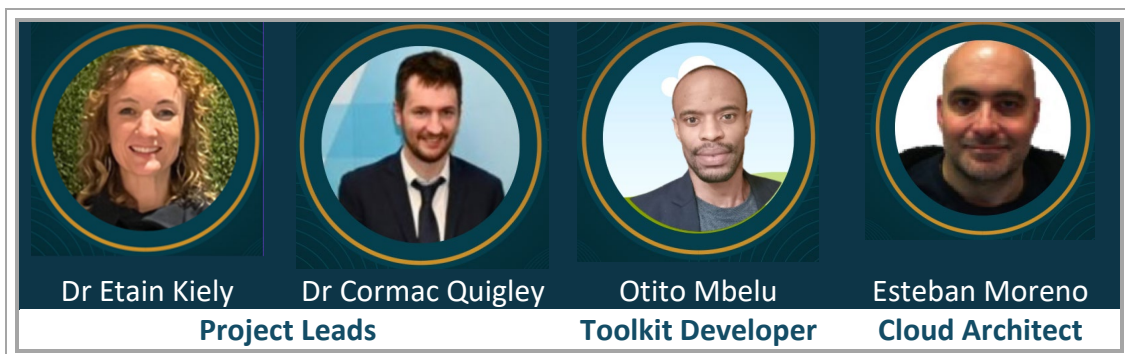


REAL Intelligent Assessment Toolkits across NFQ Levels



National and International Collaborators:

Postdoctoral Research: Process Capture and Documentation at ATU: Dr. Muhammad Irshad

Academic Contributions: Prof. Garrett Greene (Statistics, UCD), Prof. Nuala Caffrey (Physics, UCD), Prof. Stephen Power (Physics, DCU).

Formula Question Consultation: Prof. Dominique Bauer (École de Technologie Supérieure, Montréal).

Executive Summary

This study presents REAL Analytics (Reliable, Engaging, Authentic, Learner-focused) framework, an innovative, data-driven assessment toolkit designed to support scalable, competency-based learning in STEM education. Developed within the context of Ireland's National Framework of Qualifications (NFQ) the REAL analytics toolkit empowers educators to deliver precise, standards-aligned evaluations while providing students with personalised, error-specific feedback that builds confidence, fosters mastery, and supports progression across NFQ Levels.

The study employed a four-phase methodology—mapping and consultation, toolkit development, evaluation, and dissemination—to address challenges in delivering scalable, personalised assessment aligned with NFQ standards. Two Year 1 case studies in chemistry and mathematics (~350 students) informed the mapping of learning outcomes using institutional tools (Module Manager) and academic consultation. The resulting toolkit features an intuitive authoring wizard and a repository of formula-based questions, enabling educators to create adaptive assessments without technical complexity. These assessments use real, student-collected lab data to generate personalised tasks and track learner engagement—supporting progressive mastery and ensuring both assessment integrity and alignment with national qualification descriptors.

A key principle of the REAL initiative is the recognition that learning is a developmental process, with competencies strengthened through practice, feedback, and opportunities to learn from mistakes—particularly in authentic STEM contexts. This aligns with contemporary research in educational neuroscience, which shows that active, feedback-driven learning enhances cognitive engagement by reinforcing neural pathways linked to critical thinking and problem-solving. REAL Analytics thereby supports the development of both cognitive and metacognitive competencies. This understanding is further reinforced by parallel work at ATU, where machine learning and natural language processing (NLP) models have been used to trace student learning trajectories over time—revealing that consistent effort, self-efficacy, and reflective behaviours are strong predictors of academic progression. By embedding learning analytics into curriculum design, the REAL initiative advances a personalised, data-informed approach that reflects how learners build mastery—progressively and through meaningful feedback.

Key outcomes from the project include improved lab precision, increased data literacy, and strengthened feedback mechanisms. Future directions include expanding assessment formats, enhancing AI-driven personalisation, and evaluating the longitudinal impact of REAL tools across NFQ Levels. Ethical considerations, such as data privacy, algorithmic fairness, and transparency, remain central to the design and deployment of these systems. In conclusion, REAL Analytics offers a transformative model for embedding learning analytics into curriculum design—aligning assessment with national qualification standards while delivering personalised, data-informed learning. This approach not only supports individual learner progression but also drives institutional innovation in competency-based education, equipping students with essential skills for real-world STEM success.

ABOUT US

Research Team

The **REAL** project unites a multidisciplinary team of STEM education and computational experts at Atlantic Technological University Galway, led by Dr. Etain Kiely (Maths) and Dr. Cormac Quigley (Chemistry). The team has received national and international recognition, winning the International Responsible AI Award from Dataiku and the National DELTA Award in 2022, along with recent publications on using NLP to analyse postgraduate data in Ireland.



Recent ATU computing graduate Otito Mbelu developed an advanced wizard for accessible question development, while Esteban Moreno from ATU Computing Services created the supporting cloud-based architecture. Dr. Muhammad Irshad, a postdoctoral researcher, focused on the project's formula question development.

Collaborators include national experts Prof. Garrett Greene, Prof. Nuala Caffrey, and Prof. Stephen Power, who contributed authentic STEM questions, alongside Prof. Dominique Bauer from Montreal's École de Technologie Supérieure, who provided expertise in Moodle's Formula Question type.

Original Project Objectives and Outcomes Summary.

This study presents an innovative data-driven, competency-based assessment approach in STEM developed within the context of Ireland's National Framework of Qualifications (NFQ) and the REAL (Reliable, Engaging, Authentic, Learner-focused) framework. The project initially identified eight core objectives (Table 1 Project Outcome Tracker). As the project progressed, several adjustments were made in response to evolving circumstances—including challenges in recruiting a postdoctoral researcher and the drive to ensure long-term sustainability. These challenges ultimately became opportunities, prompting the adoption of more effective technical solutions and informed refinements based on early-stage insights. These adaptations allowed the project to remain agile, aligned with its strategic goals, and deliver more robust and sustainable outcomes.

Table 1 Project Outcome Tracker

Outcome Area	Project Outcomes	Specific Achievements	Status	Progress Note
1. NFQ Mapping	Map NFQ Levels across 3 universities	Mapping completed at module Level; VLE assessments identified (Levels 6–8)	 Completed	Objective met
2. Assessment Template	PowerApps interface for STEM	Replaced by a more flexible JavaScript-based tool & open-access site	 Enhanced	Technology improved

Outcome Area	Project Outcomes	Specific Achievements	Status	Progress Note
3. Sharing Questions	Share via cloud technologies	Open-access website developed for wide sharing	✓ Achieved	Outcome expanded
4. Learning Analytics	ML on interaction data	Analysis at multiple levels; results in thesis & paper	✓ Ongoing	Scope widened
5. Semester 1 Pilot	Pilot with ~1000 students	Piloted in several courses; full rollout Sept 2025	🕒 In Progress	On track with adjusted timeline
6. Student Evaluation	Evaluate learner experiences	Feedback collected and reported	✓ Completed	Objective met
7. Dissemination	Publish training and findings	Videos & documents created; website supports continued sharing	🔄 Active	Continuing rollout
8. CPD Workshops	Run with national partners	Delayed; workshop scheduled for June 2025 (ATU Galway)	📅 Upcoming	Rescheduled with new date

Context and Application of Toolkit

The team's earlier assessment research (National Forum, 2019) focused on harnessing students' data for personalised feedback forms. This work informed the Data Analytics to Inform and Enhance Learning (DAnIEL) project in 2019, which utilized data analytics to enhance feedback quality in the School of Science and Computing. Currently, in collaboration with ATU's computing services the team are applying mathematical modelling, machine learning and Azure cloud-based environments to explore scalable models for feedback and assessment. The team's research is also examining the application of NLP to analyse large volumes of qualitative data on self-regulated learning. This technology enables a more nuanced understanding of student needs, supporting tailored feedback across ATU.

This report presents evidence from the Year 1 cohort (~350 students) in the School of Science and Computing, showcasing our application of Moodle's formula question as an intelligent, adaptive assessment tool. By generating unique questions, which can include randomized values and students' individual lab measurements, the tool tracks response accuracy, time, and attempt patterns, offering detailed insights into students' problem-solving strategies, persistence, and content mastery. This data-driven approach enables personalized feedback and a clearer understanding of each student's learning progress.

The formula question toolkit, developed in collaboration with academic teams, aligns with NFQ principles by fostering mastery and skill development through progressively complex, targeted assessments across years. A wizard and repository have been created to support the academic community, with the vision of expanding this resource to further enhance teaching and learning. The open-source question database and development wizard, available online, include examples across all STEM disciplines and NFQ Levels. These resources not only support educators in creating personalized feedback but also provide learning analytics to explore various aspects of student behaviour.

Methodology

Importance of Competency-Based Assessment

This project aims to achieve the alignment of assessments with real-world skills and knowledge crucial in STEM¹ and computing fields and aims to provide a structured approach for developing^{2,3} and assessing learners' competencies across various NFQ Levels through intelligent assessment methods.

Assessment Methodology

The assessment methodology employed a three-phase approach: 1. Mapping & Consultation, 2. Development & Evaluation, and 3. Dissemination. This process is informed by internationally recognized frameworks, including the Assessment Design Decisions Framework⁴ and various taxonomies^{5,6}, ensuring a robust foundation for effective assessment practices. Aligned to the National Framework of Qualifications (NFQ), this method emphasizes stakeholder input, iterative design, and transparent dissemination to enhance educational effectiveness. By incorporating continuous feedback,⁷ the methodology ensures accurate outcome measurements and helps learners develop self-assessment skills vital for long-term retention and growth. Case studies in chemistry and mathematics are used to evaluate the impact of intelligent assessments on improving educational outcomes.

Phase 1: Mapping, Consultation and Initial Question Creation

¹ Amelink, C.T., Grote, D.M., Norris, M.B. *et al.* Transdisciplinary Learning Opportunities: Exploring Differences in Complex Thinking Skill Development Between STEM and Non-STEM Majors. *Innov High Educ* **49**, 153–176 (2024). <https://doi.org/10.1007/s10755-023-09682-5>

² H. L. Roediger and A. C. Butler. The critical role of retrieval practice in long-term retention. *Trends in Cognitive Sciences*, 15(1):20-27, 2011.

³ Freeman., S, Eddy SL, McDonough., M, Smith., MK, Okoroafor., N, Jordt., H, Wenderoth., MP. Active learning increases student performance in science, engineering, and mathematics. *SciUSA*. 2014;111(23):8410–8415.

⁴ Bearman, M., Dawson, P., Boud, D., Bennett, S., Hall, M. and Molloy, E., 2016. Support for assessment practice: developing the Assessment Design Decisions Framework. *Teaching in Higher Education*, 21(5), pp.545-556. <https://www.assessmentdecisions.org/framework/>

⁵ Anderson, L.W., 1999. Rethinking Bloom's Taxonomy: Implications for Testing and Assessment.

⁶ Thompson, E., Luxton-Reilly, A., Whalley, J.L., Hu, M. and Robbins, P., 2008, January. Bloom's taxonomy for CS assessment. In *Proceedings of the tenth conference on Australasian computing education-Volume 78* (pp. 155-161).

⁷ Osuala, R., Onwuagboke, B. and Agoha, T., 2018. Continuous assessment feedback and students' performances in semester examinations in a college of education'. *American Journal of Educational Research*, 6(6), pp.688-93.

The project team began by mapping NFQ competencies using the ATU-generated module manager tool. This involved aligning programme and module outcomes through two case studies: a Year 1 chemistry module (~230 students) and a Year 1 mathematics computing module (~120 students) at ATU. Collaborating with local and international academic staff, the team identified essential competencies for each level, focusing on both theoretical and practical skills. In mathematics, these included advanced problem-solving and statistical analysis, while in chemistry, they emphasized laboratory skills and data interpretation. In particular, through consultation with local academics and the creation of a question request form, it was possible to gauge interest in particular question types. Based on the skills identified, a range of questions were identified, and the creation of an initial “sandbox” was created within Moodle (Figure 1). This acted as a repository for questions which were either gathered from existing material or created from scratch. A range of basic documentation for question design was also produced although ultimately it wasn’t found that this improved the learning curve for potential adopters of the question type.

23-24: 99904 -- Lecturer Sandbox

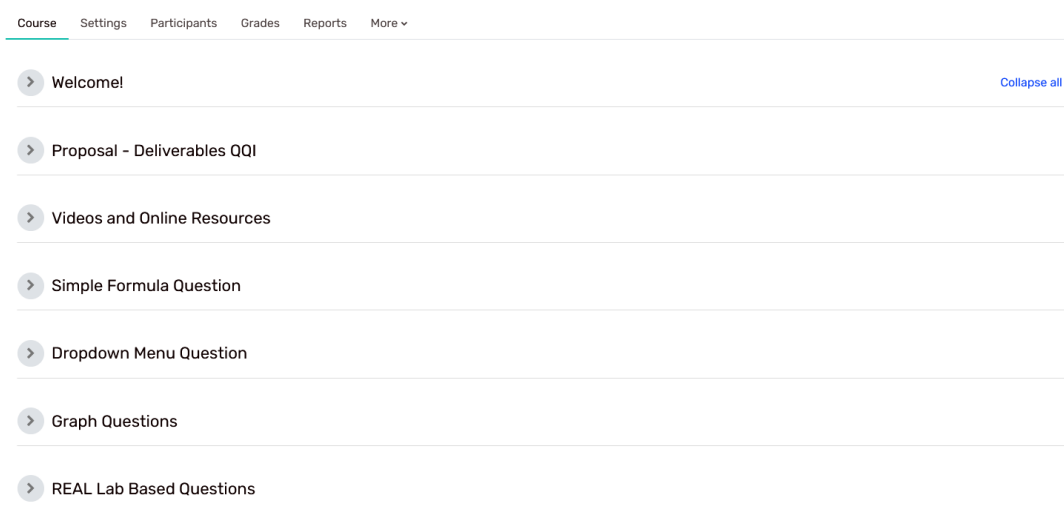


Figure 1 The original sandbox for question design and deployment

Nonetheless, the mapping exercise in combination with the creation of a small question library created a foundation which then led to the Assessment Wizard Toolkit. In addition, the sandbox proved a valuable resource locally for sharing and developing new questions with academic staff.

Phase 2: Assessment Wizard Toolkit Development

A key contribution of this project was the development of streamlined assessment wizard, embedding alignment of questions with educational standards by Otito Mbelu, a graduand and research assistant. Having attempted to produce documentation which would guide users through the editing process within Moodle, it was felt that ultimately this approach was limited by difficulties in the ability to take question into and out of Moodle and the slow nature of the question editor with Moodle. The user-friendly tool which was created allows educators to create questions using a structured, multi-step question template with a guided interface.

This was created over the course of several months in collaboration with the student researcher. The design of the interface and the creation of each of the features was directed through regular interaction with the project team and lead to the Wizard. Features which were prioritised were the ability to create questions with a reduced requirement for users to take on a full understanding of how variables work within the formula questions, an ability to write questions without a full knowledge of the syntax required for each section and an ability to rapidly edit questions. In addition, the backend, implemented in Spring Boot, organizes data by NFQ Levels for easy retrieval as presented in Figure 2 showcasing tools for efficient question creation and management. In addition, a number of instructional videos were created to assist users in developing formula questions using the wizard and editor (Figure 2).

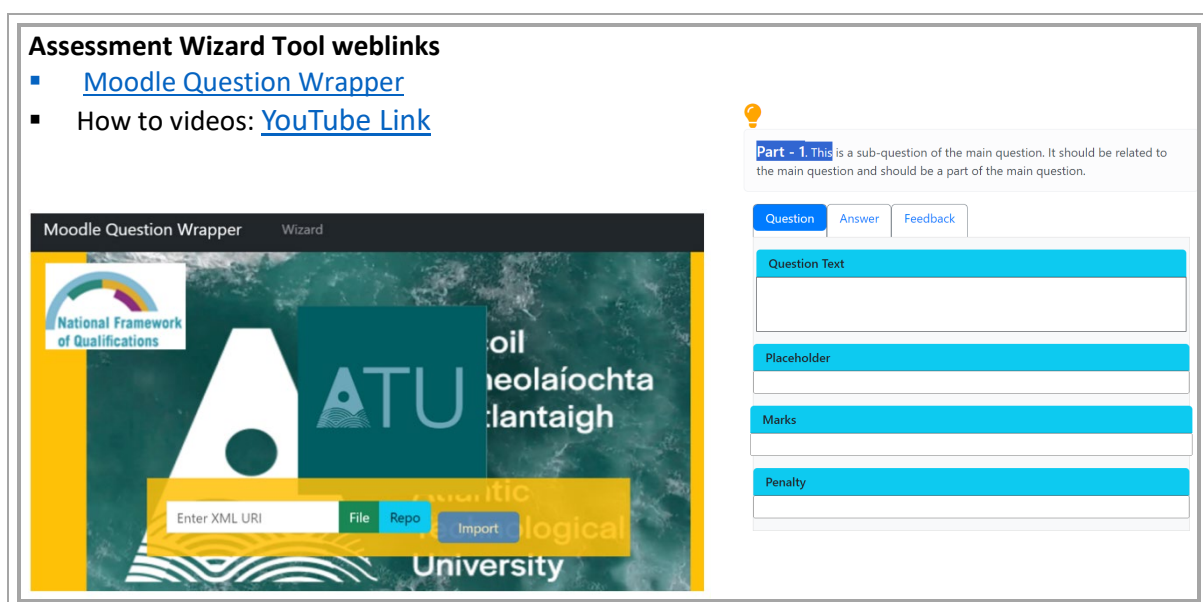


Figure 2: Landing page for the question database (left) and the question development wizard (right)

Phase 3: Evaluation

To analyse the effectiveness of STEM REAL (Reliable, Engaging, Authentic, and Learning) project two key research questions were established:

RQ1: How can student lab data from formula-based questions provide insights into learner behaviour and support skill development and inform enhancements in lab settings?

RQ2: How do mathematics mastery expectations, feedback, and advanced question types influence learner engagement, behaviour and academic success?

Case studies are given below which illustrate how each of these questions has been approached. Formula questions are a very powerful tool for creating insights into learner behaviour which can inform teaching practice. This is most effective in providing new insights in practical classes with large numbers of participants where previously there is no feasible means to collect or analyse the data generated by students at a class level.

Phase 4: Dissemination

The project shares its findings through accessible open-source platforms, including academic publications and a cloud-based toolkit that promotes collaboration. The toolkit's intuitive wizard, supported by instructional videos, guides users in creating questions, while the question repository aligns with STEM standards and the National Framework of Qualifications (NFQ), ensuring quality and relevance.

The REAL initiative not only identifies assessment challenges but highlights opportunities for improvement. Through case studies in chemistry and maths, it addresses issues like academic integrity, relevance, and the need for feedback-driven practice, offering valuable insights into advanced intelligent assessment strategies that empower educators and enhance student learning.

Project Findings/Example Outputs

Case Study: Chemistry

Phase one of the REAL project examined how formula-based questions in chemistry assess outcomes such as “knowledge,” “know-how & skill range,” and “context,” particularly for year 1 science learners. Competencies at level six evaluate students' abilities to follow documented procedures and process technical information. By integrating pre and post lab work into the Virtual Learning Environment (VLE), this approach provides authentic assessment opportunities.

This case study addresses Research Question 1 (RQ1): How can student lab data from these questions offer insights into behaviour, support skill development, and inform enhancements? As shown in Figure 2, students' grades tend to decline as lab experiments increase in complexity, likely due to the heightened demands for skills and knowledge. This trend suggests that quizzes could help students learn from their mistakes, deepen their understanding, and identify areas needing additional support.

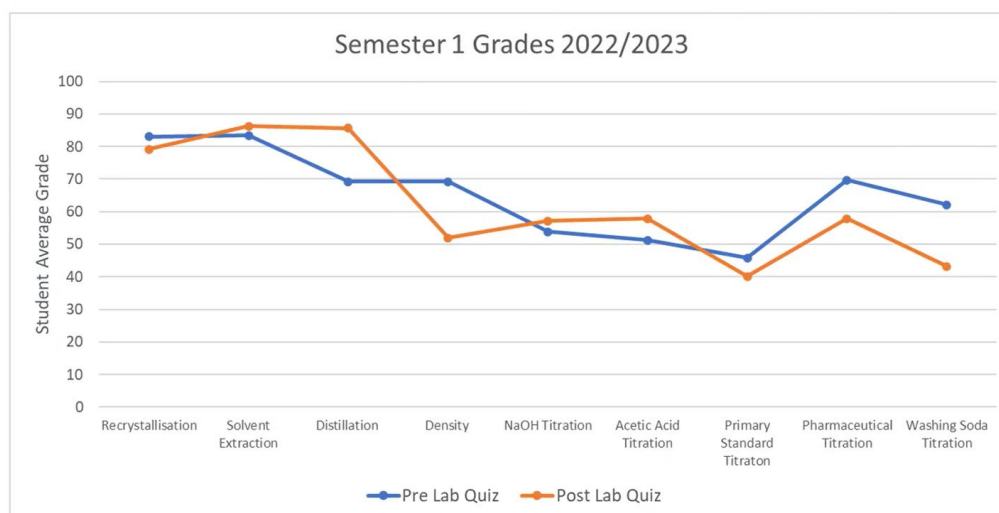


Figure 3: A graph of student grades in quizzes prior to the NFQ project (McMahon, 2023)

Question 1: NFQ 6, Knowledge Question Type

Basic Skill: Measurement accuracy and precision

This question type evaluates students' fundamental glassware skills by measuring the accuracy and precision of pipette usage. Students are required to input two calculated values from their lab measurements: one known and one unknown. Figure 3 illustrates the authentic lab measurement inputs, highlighting the calculations needed to assess personalized accuracy in measurement skills.

Question 1

Not yet answered

Marked out of 3.00

[Flag question](#)

[Edit question](#)

For this questions you will need your lab book - we are going to check your calculations:

What was the mass of your empty beaker? g

What was the mass of your full beaker? g

What weight of water have you placed in the beaker? g

What was the volume of the water you dispensed using your **pipette**? mL (or cm³)

From above, what was the mass of this water? g

Therefore the density is g.cm⁻³

Remember your density should be to **four** significant figures.

Figure 4 A quiz question requiring data from a practical setting

In another format, shown in Figure 4, students enter only the final value obtained from their practical work.

Question 2

Not yet answered

Marked out of 2.00

[Flag question](#)

[Edit question](#)

What was the density of the unknown liquid?

Input the value you have calculated based on your own values.

(Your answer is marked on a sliding scale based on how close to the true value your result was.)

g.cm⁻³

Figure 5 A quiz question which requires only a single value from student practical work

Grading Scheme:

Two skills-based grading schemes are employed to evaluate student performance, focusing on practical competencies. This approach ensures that students demonstrate their skills in real-world applications, providing a clearer understanding of their abilities and areas for improvement.

Grading Scheme:

(a) **Precision:** The first question evaluates mathematical correctness by checking students' calculations against recorded measurements. Marks are awarded if values fall within the specified error range, with penalties for incorrect significant figures.

(b) **Accuracy:** In the second question, students report an unknown value, graded solely on accuracy. Full marks are given for answers within 0.011 g.cm^{-3} of the correct value, as illustrated in Figure 5 which rewards accuracy, with higher grades given for measurements closer to the true value, a sliding scale is used for higher errors giving instant feedback on the quality of students' lab work.

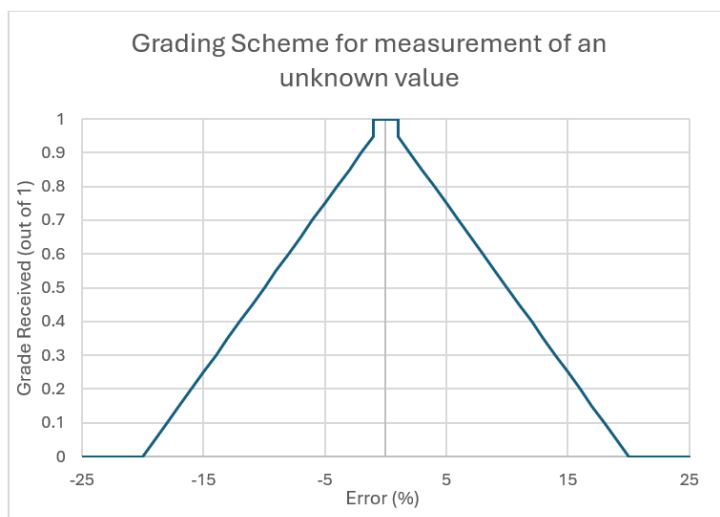


Figure 6 Grading Scheme for measurement of a known value

Feedback Scheme: Students receive the correct answers based on their input for any errors made, a feature developed during the project. As shown (Figure 6), the grading scale rewards accuracy, with students earning higher grades the closer their measurements are to the true value. Additionally, a feedback system has been integrated to provide students with corrective guidance, allowing them to understand any errors made and improve upon their skills in future assignments. This system ensures that students not only receive a grade but also learn from their mistakes, enhancing their overall performance.

Analytics:

Analysing 274 responses where students are measuring a known value (i.e. the density of water), 42 reported values fall far outside the range of expected values. By evaluating the input values we can see that approximately 20% of students make some error in the calculation or ignore it when inputting

their value while 4% of students report the “expected” value of 1 g.cm^{-3} , ignoring their own data (this obtains no marks based on the marking scheme).

Practically, looking at the student weights measured, we can see that, for correctly measured samples (i.e. those that fall within expected precision of the glassware used), the average value obtained is 0.9945 g.cm^{-3} (95% confidence interval $0.993818 - 0.995184$) is below the expected 0.998 g.cm^{-3} . This suggests at an overview, the students are not using the glassware to its full precision and are losing material during transfer (As is perhaps to be expected at this stage).

Both of these insights suggested actionable changes to practice. In the first case, tutorial classes have been changed to allow greater examination of practical calculations (in our case involving a change of timetabling to run the tutorial and lab in sequence where previously they had been scheduled separately). In the second, a greater emphasis on complete transfer during the practical class was added to the instructor notes.

Question 2: NFQ Level 6 Competencies

Know How & Skill Range: Assesses students' ability to analyse data, perform calculations, use laboratory equipment, and solve problems.

Question 1

Not complete

Marked out of 5.00

[Flag question](#)

[Edit question](#)

What were your three precise titration values?

mL, mL, mL

What is the average titre value? mL

Was the liquid you dispensed into the conical flask with the pipette the analyte or the standard?

If it was the standard, what was its concentration? M

What volume of liquid did you dispense from the pipette? L

What number of moles of HNO_3 were contained in the liquid which you dispensed? mol
(Remember M = molarity = moles per liter)

Examining the equation for the reaction of NaOH and HNO_3 , what is the ratio of the reaction between them? :1

Therefore, assuming that the endpoint is when enough Sodium Hydroxide (NaOH) has been added to use up all of the Nitric Acid (HNO_3) but no more, how many moles of NaOH have been added to the flask? mol

Going back to your earlier value for the average titre: mL, what is the average titre in liters? L

Therefore, what is the concentration of your Sodium Hydroxide Solution? M

Figure 7 A question based on input data and calculations

This question Figure 7, assesses students' ability to analyse data, perform calculations, and use laboratory equipment. After completing a titration, students enter three lab-determined titre values for a post-practical assessment.

Grading Scheme: The grading checks that measured values are within the expected precision (0.1 cm^3) and that students correctly identify used glassware or solutions. A penalty is applied for incorrect significant figures.

Feedback Scheme: Each subpart includes individual feedback. Students receive precision data for inadequate measurements and correct values for calculation errors. Images of relevant lab equipment are shown to clarify the relationship between calculations and practical work. An example of the

feedback is shown below where a student has completed the correct calculation but has not completed the lab work to the expected standard. Here, it compares their result with the expected result to give the student real time feedback on the quality of their work.

Question 1 Partially correct

This quiz question requires you to enter data collected during your own lab where you carried out a titration.

What are your three precise titration values? (Note: these are the volumes you dispensed from the burette and are called **titres**)

15.1 mL, 15.2 mL, 15.3 mL

Calculate the **average titre** value in the unit of mL. 15.2 mL

You have correctly calculated the average titre but your precision is not sufficient - next week make sure you end with three values within 0.1 mL.

You will need to improve your technique to get the required precision - ask your lecturer to troubleshoot your technique if you are finding it hard to get precise results. You are expected to get a precision of 0.1 mL or better but the precision of your values is 0.2 mL.

Figure 8 Question showing feedback for partially incorrect responses based on student data

Again, had they miscalculated their average titre they would get specific feedback “Based on the three values you gave the average should be {Part1_answer[1]} mL but you gave the answer {atu_input1[3]} mL.” which would allow them to see the correct answer based on their measured values.

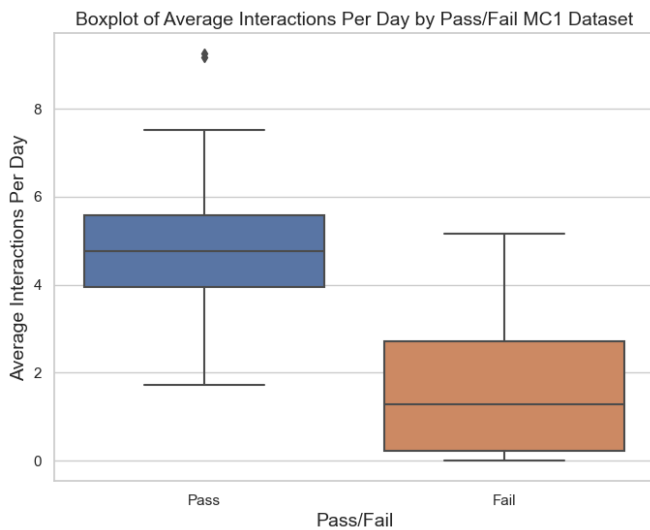
Analytics: Data collection allows evaluation of precision achievement rates and identification of calculation errors. Notably, 22% of students initially failed to identify the correct pipette, and 16% did not correctly identify the standard concentration from labels.

Case Study: Maths

RQ2: How do mathematics mastery expectations, feedback, and advanced question types influence learner engagement, behaviour and academic success?

The learning analytics research team’s used machine learning models (Ogbuchi, 2023) to explore Virtual Learning Environment (VLE) data, examining the connections between student engagement metrics and academic success. Quantitative and qualitative data findings consistently reveal that learners value mastery quizzes highly, with these activities driving significant engagement online. High levels of interaction with quizzes are predictive of academic successful outcomes.

Key Insights:



Engagement Patterns: Figure 9 shows students daily interactions. Those who passed the course interacted with the content between 1,000 and 2,000 times, demonstrating a strong link between consistent engagement and success. In contrast, students who did not pass typically engaged less, falling between 0 and 1,000 interactions. Moreover, our model was able to predict, based on early data (weeks 5 and 7 semester 1), and accurately identify over 70% of students at risk of non-progression.

Figure 9 A boxplot showing the importance of online engagement with academic success

Predictive accuracy continued to improve over time, supporting the use of early intervention assessment metrics to aid student learning. These findings highlight the role of interactive and thoughtfully designed question types in fostering an engaging and successful learning environment.

The research model employs the use of built-in Moodle’s VLE analytics providing educators with valuable insights into question quality and student performance. By leveraging analytic metrics like the *Facility Index* and *Discriminative Efficiency*, educators can evaluate how well individual questions meet educational standards and whether they are appropriately challenging. This functionality helps identify questions that may require revision or improvement, ensuring assessments are both fair, high quality and effective. Additionally, this level of analysis supports data-driven instructional decisions, allowing educators to refine question types that drive engagement and improve learning outcomes. By continuously monitoring and adjusting question quality, VLEs can foster a more adaptive learning environment tailored to student needs and aligned with NFQ standards implemented at programme and module level.

Conclusions and Implications

The REAL Project exemplifies the transformative potential of innovative assessment practices in enhancing both student learning experiences and quality of curriculum development. The project uses data informed analytics models to inform and drive the quality of the learning experiences. The findings of this project suggest that by resourcing advanced question development within the VLE, the student learning experience can be significantly improved.

Key Contributions

- **Elevated Assessment Experience:** The REAL Project enhances Moodle's quiz functionalities by offering a user-friendly “Question Design Wizard” and establishing an open-source repository of NFQ-aligned questions. This integration allows educators to create assessments that embed progressively complex NFQ competencies, supporting objective of enhancing assessment reliability.

- **Detailed Feedback Mechanism:** By incorporating real-time, detailed feedback into assessments, the REAL Project empowers educators to provide targeted insights that help students understand their performance and identify areas for improvement.
- **Strategies for Academic Integrity:** The REAL Project emphasizes academic integrity by linking assessments to real-world data and unique scenarios which fosters originality and authentic learning experiences.

Transforming the Learning Experience

The REAL Project exemplified how to lead in the transformation of traditional assessment creation by enriching the educational journey in an ever-changing education landscape. The focus on relevant learning ensures that reliable assessments align with NFQ competencies, enabling students to develop essential skills and knowledge that prepare them for diverse and emerging career trajectories. By empowering educators with data driven insights into effective question and course design, the project create impactful assessments that resonate with learners. This comprehensive approach enhances the overall educational experience, ensuring that assessments are not only effective but also meaningful.

Future Work and Direction

As part of ATU's broader learning analytics research, the REAL Project is committed to continuous improvement and innovation. Our future research directions will continue to expand our contributions by

- **Providing Diverse Assessment Formats:** to broaden the assessment offerings by creating a variety of question formats that cater to different learning and competencies, ensuring all students have the opportunity to succeed. If interested in contributing to the project please reach out to the team leads.
- **Developing AI-Powered Personalization:** to leverage advanced artificial intelligence models within the REAL framework to design adaptive learning experiences that cater to individual student strengths and needs, promoting mastery through real-time feedback mechanisms. This will include expanding and ranking key AI features and predictors for academic success. Beyond this the team are using NLP to explore large qualitative data sets to explore self-regulated learning in higher education.
- **Examining Longitudinal Impact:** to investigate the long-term effects of REAL assessments on student outcomes, focusing on developing complexity of knowledge and skills development, retention, and application as learners progress through NFQ Levels. The DELTA Award (2022) winning team is continuing this evaluation to ensure skill development is captured across chemistry modules in ATU.

The REAL Project funded by QQI is dedicated to leading and shaping the future of educational assessment. This commitment to reimagining assessment frameworks will empower the next generation of learners, ensuring they are equipped with the skills and knowledge necessary to not only succeed and thrive but contribute to the ever-changing educational landscape. The research conducted in this publication was funded by Quality and Qualifications Ireland under grant number ATU20231.

Appendix 1: Guide to the Moodle Question Wrapper

The Moodle Question wrapper acts as a repository for formula questions, provides a wizard for the initial writing of new questions and the rapid editing of existing questions. The home screen (Figure 10) allows the user to access it's three functions – the wizard, the editor and the library.

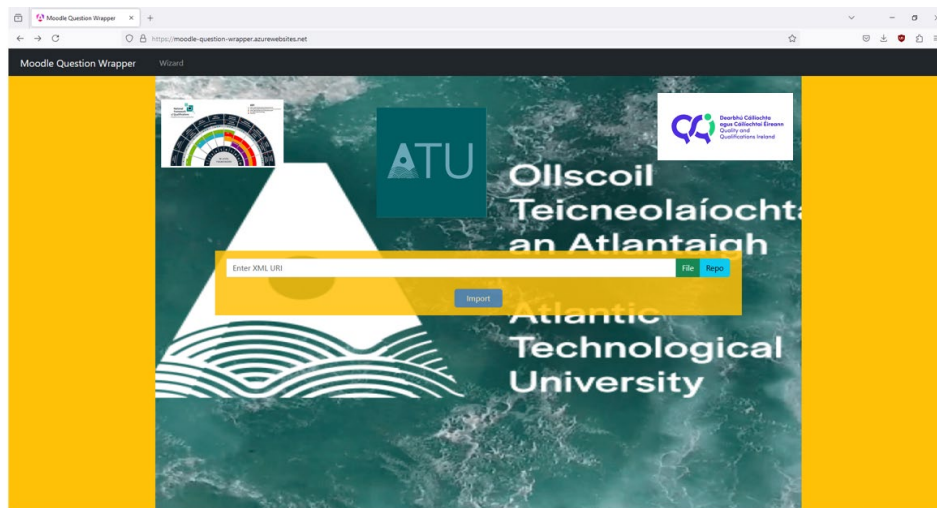


Figure 10 Moodle question wrapper home screen.

The first function of the wrapper explored here is the wizard. It allows the user to write formula questions with assistance to reduce the learning curve and prerequisite knowledge. It takes the user through each required step and provides dropdown menus to allow the users to achieve the correct syntax and format for e.g. variables. The first step, Figure 11, is to name the question and add in any tags as appropriate.

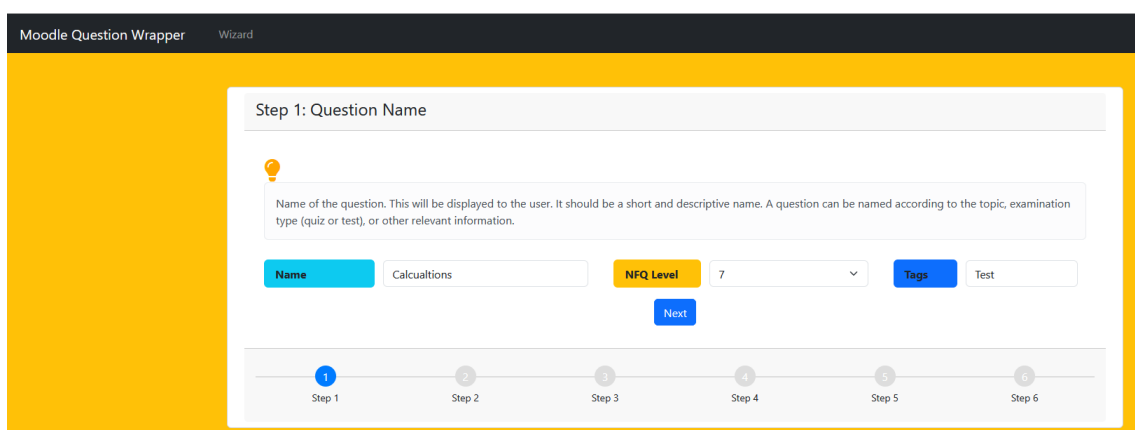


Figure 11 Step one – name the question and add any descriptive tags as necessary.

This is followed by a basic question layout (Figure 12), i.e. choosing the number of question parts which can be placed in any order within the final question text.

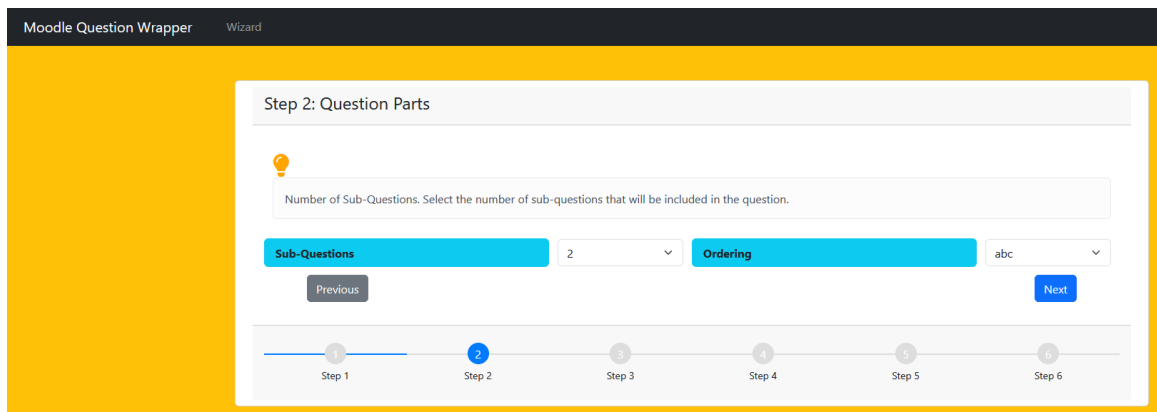


Figure 12 Choosing the number of question parts.

Variables for all parts of the questions are set up. Drop down menus for each part allow the user to choose between sequences or sets and shuffled sets. The sequence variable type allows the user to define a range over which a random number will be chosen at the beginning of each question attempt. Sets allow for an array of individually defined items to be specified. Figure 13 shows how the syntax of the variables is created for the user by the wizard and drop down menus allow for editing each aspect without error.

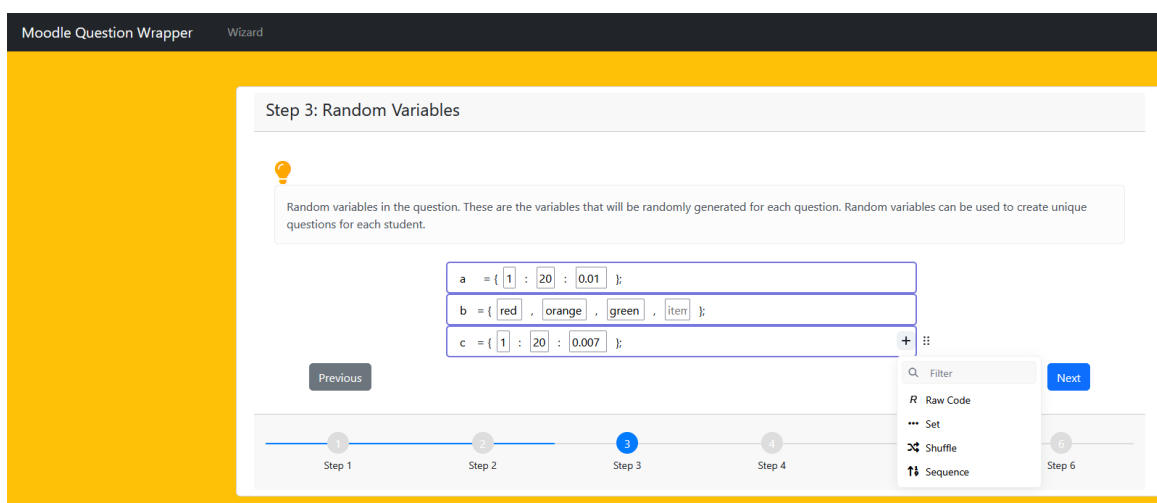


Figure 13 Creating global variables.

Global variables are set in the next screen. Here, it is possible to create new variables which are either fixed or can be based on the variables set in the previous screen. Again Figure 14, the wizard offers the user a drop down menu to ensure ease of use. In this case, it is populated with the variables the user defined in the previous screen and allow for the creating of variables without syntax issues.

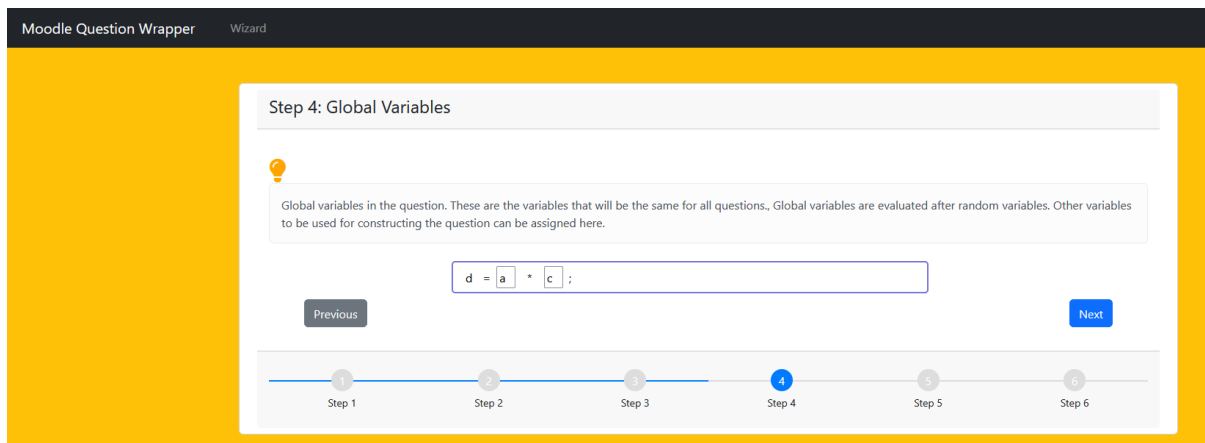


Figure 14 Global variables are created with an option to use already declared random variables.

Step 5 allows for the creation of questions, answers and feedback based on the variables which have been declared in the previous screens. Again, drop down menus allow the user to select the existing variables and place them into the question, the expected answers and the feedback. The number of sub questions to be completed depends on the choice made in step 2. Finally, once all parts are completed, the question can be previewed and downloaded as an xml file.

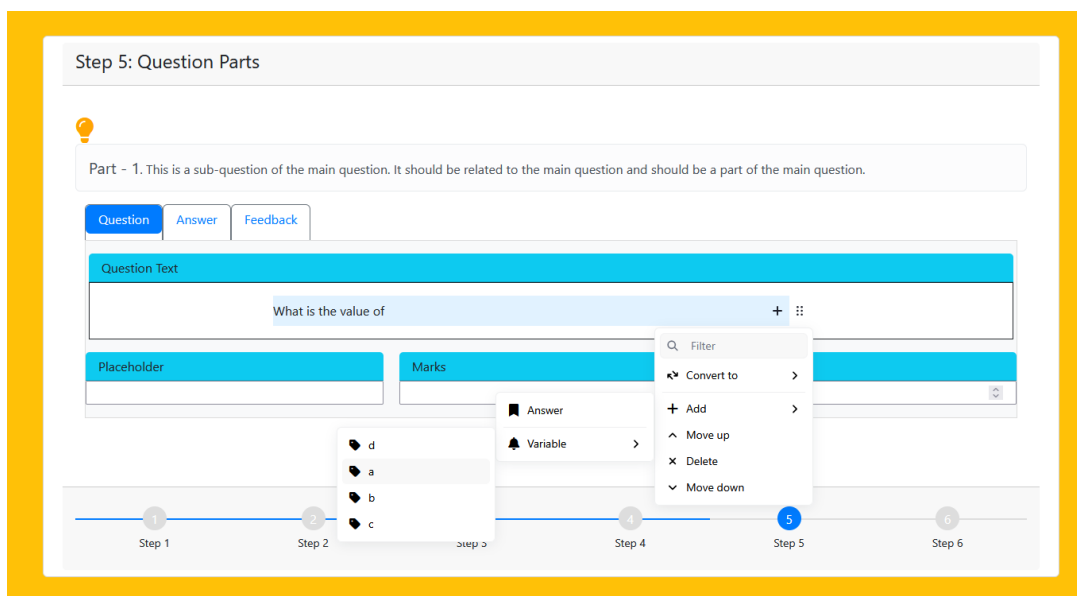


Figure 15 Question design screens.

The question design screen contains three tabs which the user can go between freely. The question tab requires the input of the question text and the marks for that section. The answer tab can be populated to define the criteria for each answer. The grading criteria can either be defined using preprogrammed options such as relative error. Alternatively, grading criteria can be manually

created at the user's requirement relative to grading variables which can be any combination or function of all of the previous variables.

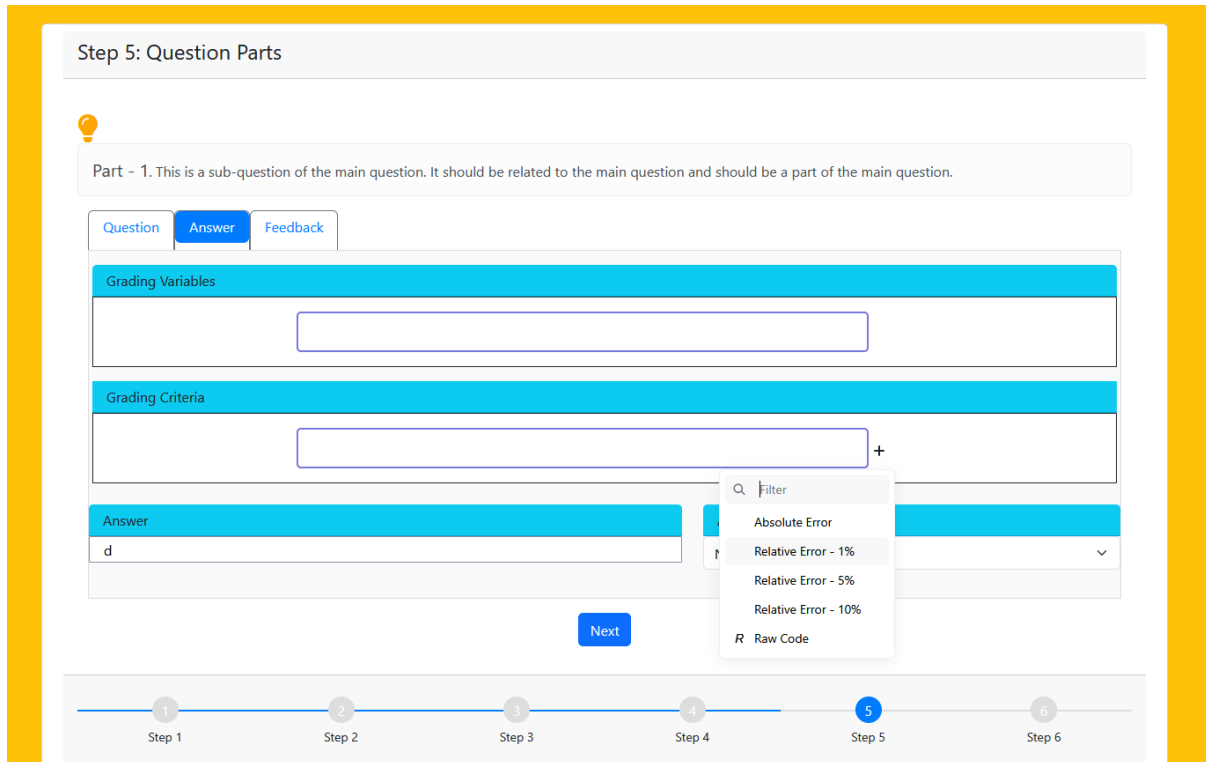


Figure 16 Answer tab showing the possibility to declare grading variables and criteria.

The third tab (Figure 17) gives the space for including feedback for correct, partially correct and incorrect answers. The final page (Figure 18) allows the user to order each part of the question created as well as place any leading or following text around the individual parts. The question can then be previewed and downloaded as an XML file.

Step 5: Question Parts

Part - 1. This is a sub-question of the main question. It should be related to the main question and should be a part of the main question.

Question Answer **Feedback**

Correct Feedback

Partially Correct Feedback

Incorrect Feedback

Next

Step 1 Step 2 Step 3 Step 4 **Step 5** Step 6

Figure 17 Feedback can be given for each answer category and can include variables such as the correct answer.

Step 6: Question Preview

End User Question Preview. The Preview shows the output of the question to the final users. You can preview the question before saving it or Choose to Modify the Main Question Text.

Main Question Text

Preview

Previous **Finish & Download**

Step 1 Step 2 Step 3 Step 4 Step 5 **Step 6**

Figure 18 Final screen within the wizard for preview and download.

The second function of the question wrapper is as a direct editor.

The question downloaded from the wizard question can, if desired, be further edited using the question editor. To edit a question, the file is uploaded through the home screen (Figure 19). Either using a web link to the file or by uploading it through the file picker.

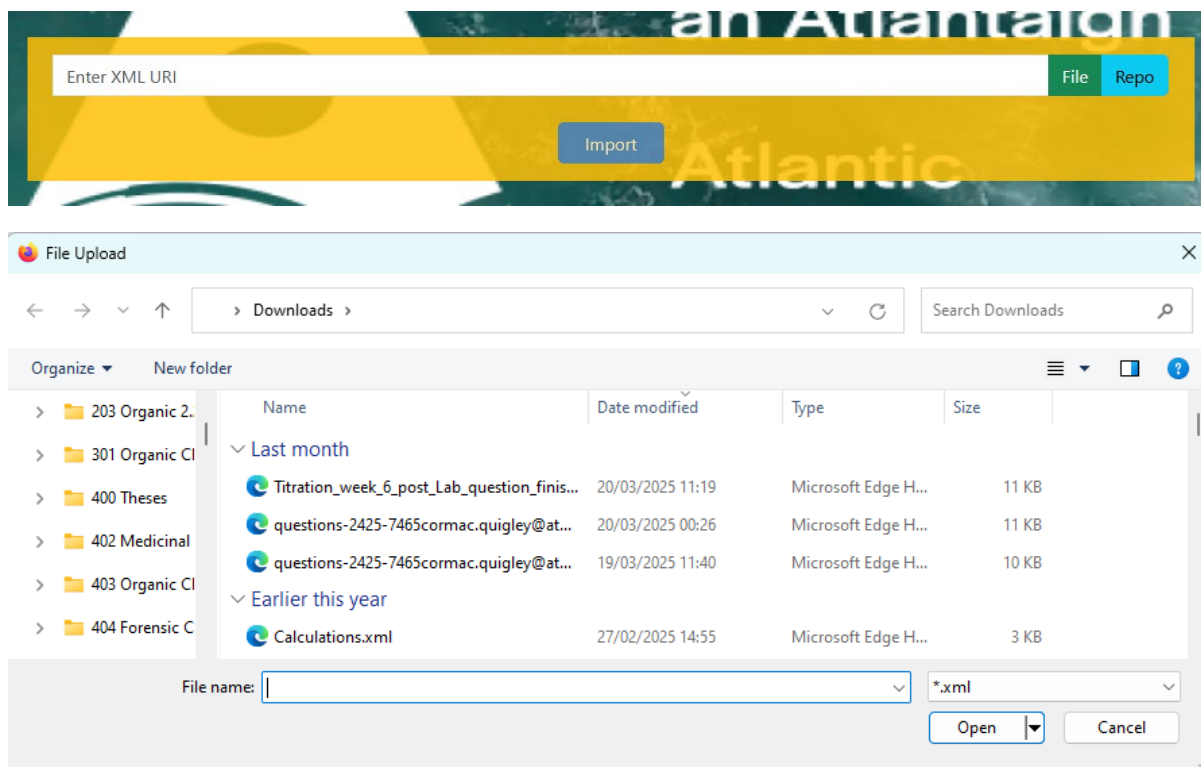


Figure 19 Files are uploaded directly from the user's device.

Once imported, the question can be edited freely and then it can be checked for validity. Each part of the question is listed and can be edited separately.

Figure 20 Direct question editor

This question editing facility is also a convenient and powerful way of editing formula questions from other sources. It has a particular advantage that it does not require the user to log in or load up Moodle. Edits can be saved instantly without modifying an existing course's question bank directly to the user's file storage.

Finally, the question wrapper also contains a repository of existing questions which can either be directly downloaded or used in the editor as the basis for a new question. These are download only and cannot be changed by the end user until they are exported however it is our intent to add further to this library as our own question bank develops. They can be searched by tags and NFQ level providing a convenient user experience.

Figure 21 The question repository

Appendix 2: Planned Workshop

Workshop June 2025

Venue: ATU Galway Campus

This workshop will cover the fundamentals of using and creating formula type questions. It will examine how they can be relevant at a range of NFQ Levels and how feedback and grading schema we use in other situations can be incorporated into Moodle questions to create engaging and effective assessment material.

10:00 – 10:30	Introduction. Examining alignment to QQI standards. How do we assess through the VLE at each NFQ Level?
10:30 – 11:00	Intro to formula type questions. Exploring the basic functions and generating MCQ, numeric and advanced question types.
11:00 – 11:30	Understanding grading schema and translating them into computable statements
Coffee	
11:50 – 12:20	Giving feedback and advanced feedback design
12:20 – 13:00	Using student generated data in quiz questions