

Strategic Innovation Fund (SIF) 2
Repositioning Assessment for Learning
Action Research Projects
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Title of Project: Assessing for learning and quantitative literacy on a first year business quantitative techniques module
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PROJECT CONTEXT

The first year *business quantitative techniques* subject was taught in September 2009 on a pilot basis in a lecture theatre to approximately 280 students, complemented by weekly tutorials for students. This project initially set out to support student learning through the development of online formative tests for each topic, with integrated feedback and multimedia sample solutions (mathcasts produced by recording the narrated screen activity when writing the solution on a tablet laptop). As previous research indicates, there is much potential for online assessment to support learning by providing students with fast and useful feedback.

This is an action research project aimed to improve practice and enhance students' learning. It evolved into the first action research cycle with a broader focus than set out above, to include promoting quantitative literacy and encouraging meaningful engagement in a large lecture (a primary concern was how to address the challenges of teaching business quantitative techniques in a large lecture environment).

PROJECT RATIONALE

The learning outcomes of a traditional business quantitative techniques module are traditionally calculations focused, with students focusing on learning the mathematical steps in producing a numerical answer. The issues we attempted to address included broadening the assessment approach to include elements to promote quantitative literacy, as well as encouraging meaningful engagement in a large lecture setting and the use of online quizzes as a means of providing immediate feedback.

PROJECT AIM(S)

The project aimed to evolve a learning environment conducive for our students to engage and succeed, by focusing particularly on assessment. In particular, the project aimed to:

- **Promote quantitative literacy:**
We introduced three assignments, requiring students to write short reports to critique a graph, to comment on an article and to use one of two online statistical applets to develop an understanding of a statistical issue (averages or sampling).
- **Encourage meaningful engagement in a large lecture:**
We used in-class activities with peer discussions, including piloting activities based on student generated data using clickers and online surveys. In addition, we incorporated statistical applets and relevant short videos (some humorous).
- **Use of online quizzes and resources:**
We developed an online quiz and a number of online resources, incorporating presentations, interactions, quiz elements and screencast solutions.

PROJECT LITERATURE REVIEW

Life in the twenty-first century is digital; it is full of numbers. Coming to good decisions requires everyone to be comfortable with numbers, to be able to both use and challenge quantitatively based arguments. Quantitative literacy is the ability to know when and how to work with numbers in particular contexts, as well as to critically evaluate and communicate the results. It underpins reasoning in many contexts including cultural, personal health and finance, management, work and citizenship. In higher education, the mastery of specific quantitative techniques needs to be complemented by the development of a broader understanding, the preparation of qualitatively literate workers and citizens.

Good practice from the quantitative literacy literature

Boaler, Ben-Zvi, Frankenstein, Garfield, Gutstein, Lesser, Schield, Skovsmose, Steen, Wiggins ...

When teaching for quantitative literacy, we should strive to:

- ✓ attend to working in different contexts and establishing connections
- ✓ use open-ended authentic problems
- ✓ require students to explore unclear situations with quantitative techniques
- ✓ encourage critical interpretation and clear communication
- ✓ engage, challenge and motivate students
- ✓ harness technology to alleviate mathematics anxiety and reduce calculations burden

Integrating into teaching practice

Moving the emphasis from calculations to understanding, from quantitative techniques to quantitative literacy using the following approaches:

- ✓ in-class activities with peer discussions
- ✓ activities based on student generated data using clickers and online surveys
- ✓ short written assignments
- ✓ team projects – reports and presentations
- ✓ guided discovery using interactive online activities
- ✓ online formative assessments

A full discussion of the above, including a substantial literature review, is available in Raftery (2007). Other sources useful for this project included articles from *Teaching Statistics* and other journals, and materials from the AIMS project (*Adapting and Implementing Innovative Material in Statistics*) and the related book Garfield and Ben-Zvi (2008). On the use of clickers, Boyle and Nicol (2003) and King and Robson (2009) amongst others were consulted.

PROJECT METHODOLOGY

For each of the three specific project aims, appropriate learning activities, teaching approaches and assessment tasks were developed in the *Project Activities and Findings* section below. Evaluation was undertaken via an online student survey and a small student focus group (both undertaken in May, after classes has ceased but before final exams). We had intended to track student usage of online resources via Blackboard but due to a server error these statistics are unavailable.

Students were asked to complete an anonymous short online questionnaire at the end of the academic year and our results are based on the replies to this questionnaire which had a response rate of over 27% (77 out of 282 students who registered for the final exams). As the survey was administered online, the sample is self-selecting leading to potential sample bias. Thus a note of caution when interpreting the results of the survey is that those who did not response *may* differ from those who did.

In the project, we sought to increase the focus on quantitative literacy by broadening the assessment approach to include elements to promote quantitative literacy, in particular by using written assignments. We also sought to encourage meaningful engagement in a large lecture setting, including the piloting of clickers. Finally, we piloted the use of online activities and support through the virtual learning environment (Blackboard), in particular online quizzes and online resources.

Written assignments

The students had three written assignments, each requiring a short report (1 to 2 pages). The first assignment one was to select a published graph and to write short critique of the selected graph. The second assignment was to choose one of two newspapers articles on the use of statistics and to write a short report on the chosen article, and the third assignment to use one of two online statistical applets to develop an understanding of a statistical issue (sampling: Irish Proclamation assignment, see Figure 1 below; or, averages: Sticky Notes assignment adapted from Michelle Everson, link to applet <http://projects.cehd.umn.edu/EdPsy/sc/>).

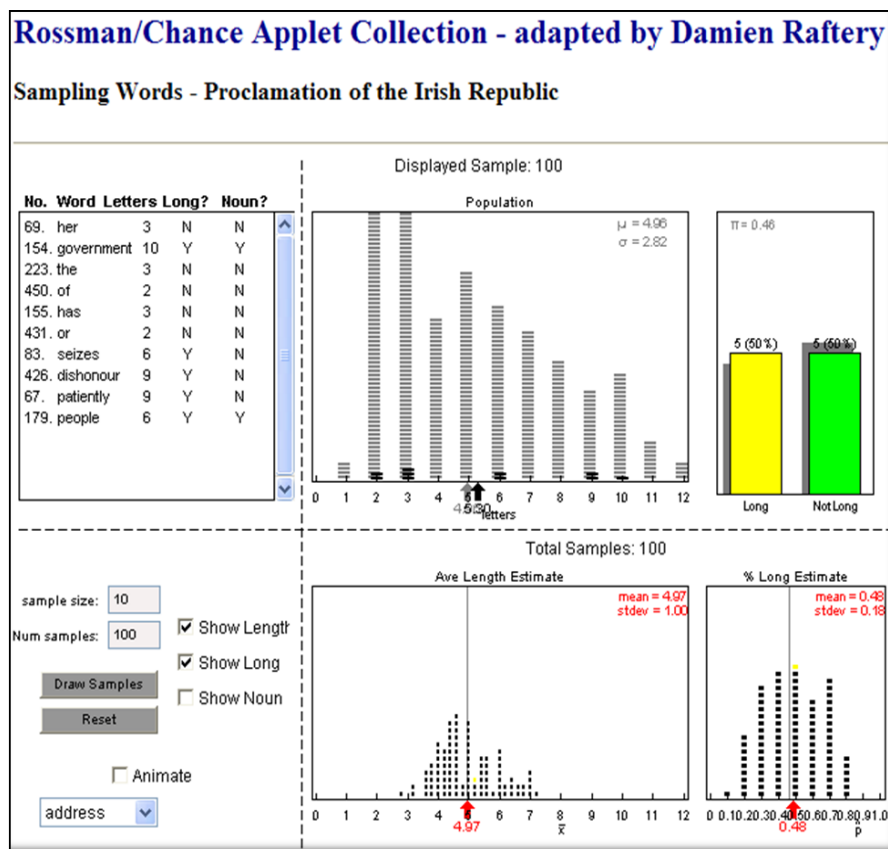


Figure 1 – screenshot of applet for third assignment (applet adapted with permission by Raftery from Rossman/Chance applet, available with assignment adapted from AIMS, details via <https://dspace.ndlr.ie/jspui/handle/10633/2521>)

The majority of respondents agreed that the assignments helped them *understand what statistics is really about*. Over half found the assignments interesting. Overall students found these assignments very time consuming and many commented that more detailed brief would have been helpful. Students also felt that more marks should have been allocated to these assignments as they were very challenging and time consuming. Over 60% of the questionnaire respondents felt that the assignments helped them learn the relevant module content.

The majority of students completed the written assignments. The quality of work was mixed, with some excellent reports. Many students, including weaker students, demonstrated both an interest and a willingness to express an opinion, as well as progress towards quantitative literacy. Poor referencing was common, as was the standard of the written work. Some student expressed a preference for these assignments over more numerical/mathematical assignments.

Encourage meaningful engagement in a large lecture, including using clickers

The business quantitative techniques module is taught with a primary focus on solving problems. This naturally allows for the integration of activity – students doing things – within the lecture setting. A standard approach would be to introduce an idea or technique, conceptually followed by an example and then set an activity for students to work on. Often students are asked to worked individually at first, then share their answer and approach with each other in small groups of two to three students. At that point a solution and feedback on possible difficulties would be presented. To spark interest when introducing an idea or technique, sometimes appropriate thinking challenges (or provocative questions) would be posed or short videos from YouTube would be shown (these short, often humorous, videos were very popular with students despite having an overt relevance to the topic being introduced, for example a short clip from the BBC comedy series *Yes Minister* in which Sir Humphries explains how to ask questions in a way to ensure you get the answer you want <http://www.youtube.com/watch?v=Hjh13hxeh14>). At the beginning of the year, students completed an online survey used to capture data that could be analysed in class (using real data collected from the students themselves promotes greater interest and engagement). Another short survey randomly assigned students two versions of the same question (designed to encourage different answers) and the results were revealed and discussed in class. Statistical applets were used to demonstrate concepts, with links provided in Blackboard for students.

Clickers (classroom response system) were piloted in the lecture to encourage meaningful student participation. For two lectures introducing a specific topic (probability) and for two revision lectures, clickers were used. The activities-focused approach of the lectures extended to the natural integration of clicker activities, activities in which the students had to choose from a list of options or enter a numerical value. The clickers were allocated to students on the basis of one clicker to two to three students, depending on the lecture size. Students were presented with a question or problem and asked to select an answer after a short group discussion. Depending on student responses, the lecturer then discussed these responses or gave the students additional

explanations on the subject and then with this additional information, the groups were asked to try the question again, as can be seen in Figure 2a and Figure 2b below.

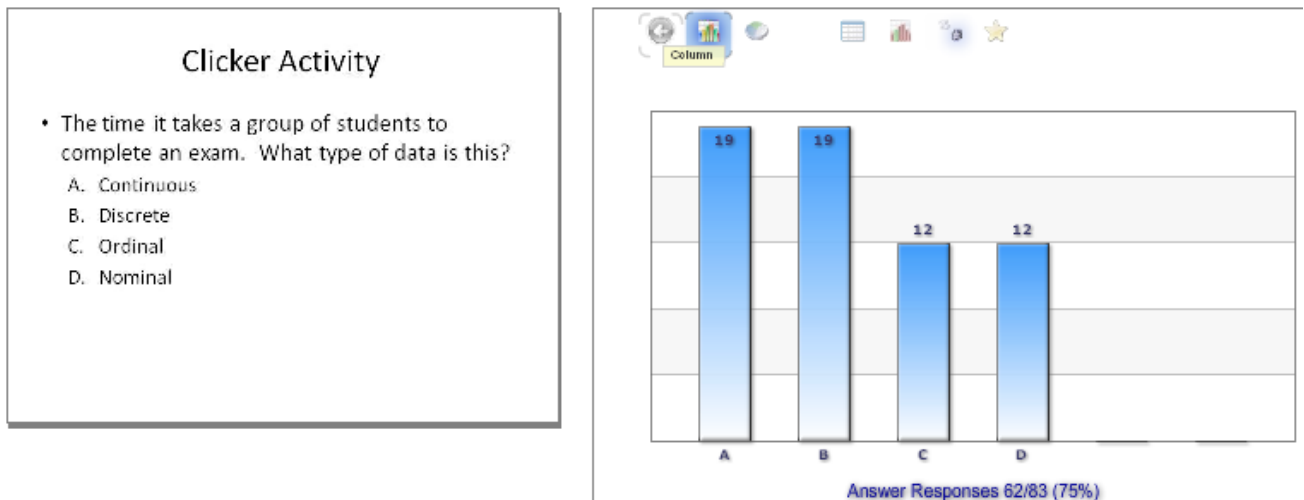


Figure 2a – PowerPoint slide of example clicker activity, with a bar chart showing students’ choices – note that only one answer is right and that many students have picked the wrong option.

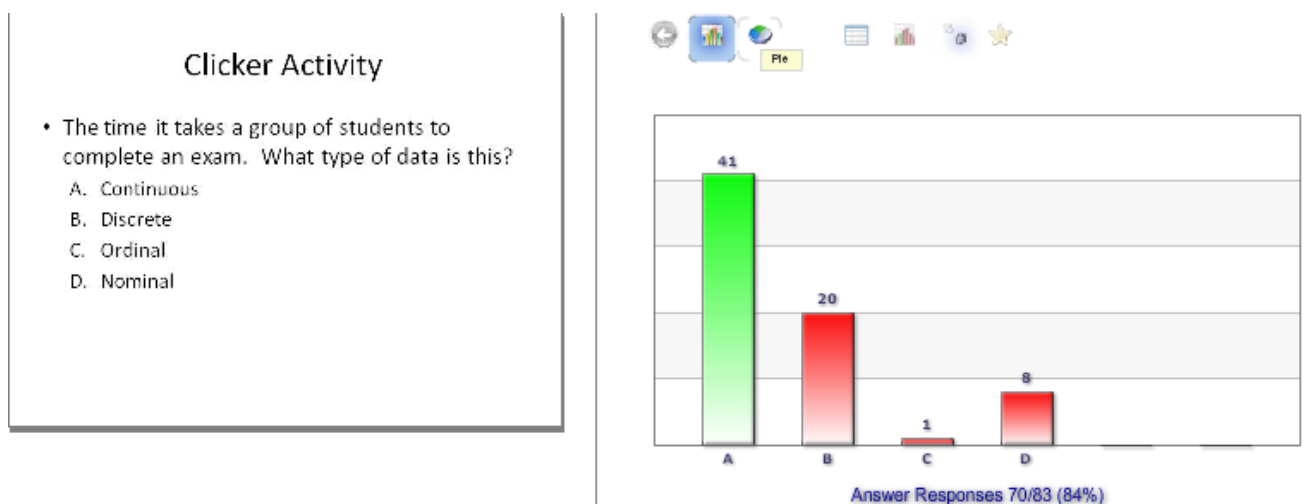


Figure 2b – Second attempt at same clicker activity after further peer discussion – note that many, but not all, students have now selected the correct answer.

Overall the students enjoyed using the clickers and over three-quarters found them useful. 60% found clickers helpful to their learning, particularly finding them most useful when they were combined with peer discussion time.

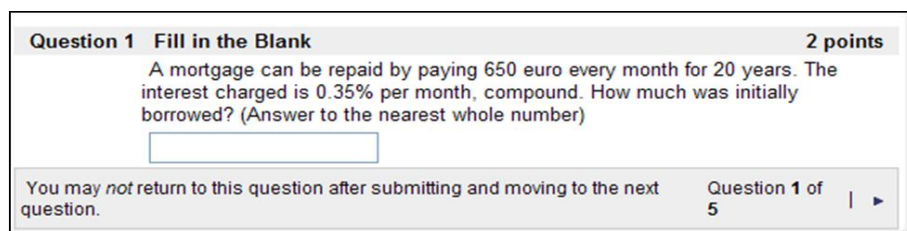
“Liked the immediate response clicker gives like you can see what % voted and what % was most popular and it updates so fast on screen. Made the class much more interactive and I felt I was more focused.”

“I enjoyed using the clickers they made the lectures fun and interesting.”

Online quiz

An online quiz on financial maths was developed and piloted. The quiz consisted of five different financial maths questions based on compound interest and continuous investments. Students were allowed to attempt the quiz as many times as they wished over a fixed time period of two weeks but only their last attempt would be recorded. The time period was initially one week but due to server downtime the quiz was not available to the students for some of the initial week so the quiz was made available for an extra week. Students did not have to complete the quiz in one sitting, they could exit the quiz and return to the same question later.

The questions were presented to the student one-at-a-time and the student had to submit the answer to each question before getting access to the next question. When the student completed the final question and submitted the quiz, they got immediate feedback in the form of an overall test score and the questions answered incorrectly were identified for them. The students could not return to a question once they had submitted their answer.



The screenshot shows a quiz question interface. At the top left, it says "Question 1 Fill in the Blank" and at the top right, "2 points". The question text reads: "A mortgage can be repaid by paying 650 euro every month for 20 years. The interest charged is 0.35% per month, compound. How much was initially borrowed? (Answer to the nearest whole number)". Below the text is a rectangular input field. At the bottom left, a note states: "You may not return to this question after submitting and moving to the next question." At the bottom right, it shows "Question 1 of 5" with a right-pointing arrow.

Figure 3 – example questions from the online quiz in Blackboard

Each of the five questions was randomly generated from a specific bank of similar type questions and each of the five question banks contained between twenty and thirty questions. This reduced the chance that a student would get the same selection of questions if they attempted the quiz more than once, and it reduced the chance of two students getting the exact same set of questions. All questions were open-ended questions and required the student to do some calculations in order to arrive at the solution. Examples of all of the questions had been covered during lectures in the weeks previous to the quiz.

Overall, students preferred doing the online quiz than an in-class test and the majority of students performed better in the online quiz compared to the in-class test. Also, many of the students attempted the quiz more than once in an attempt to improve their score and liked the fact that the quiz did not have to be completed in one sitting.

"I felt it was very beneficial as you didn't have a time frame to finish the test. It made me more determined to find the solution if I wasn't sure how to tackle the question"

Solutions had to be exact, so if students rounded their answer incorrectly the question was marked incorrect, students found this unfair and very frustrating, however Blackboard 8 will enable a range of values to be entered as possible solutions which will overcome this problem. Students did not like the fact that the computer only recorded their latest quiz attempt and not their best score.

Online resources

A number of online resources were created, including interactive online presentations, screencasts showing handwritten solutions to problems and online crosswords. In Figure 4 below, students can view a short presentation introducing boxplots, explore a interactive guided image by clicking on parts to show brief explanations, watch a video demonstrating how to draw a boxplot and try a short quiz to check their understanding (incorporating a variety of question types including hotspot, fill-in-the-blank, multiple choice and ordering). This learning resource evolved through a number of versions and was created using Articulate Studio.

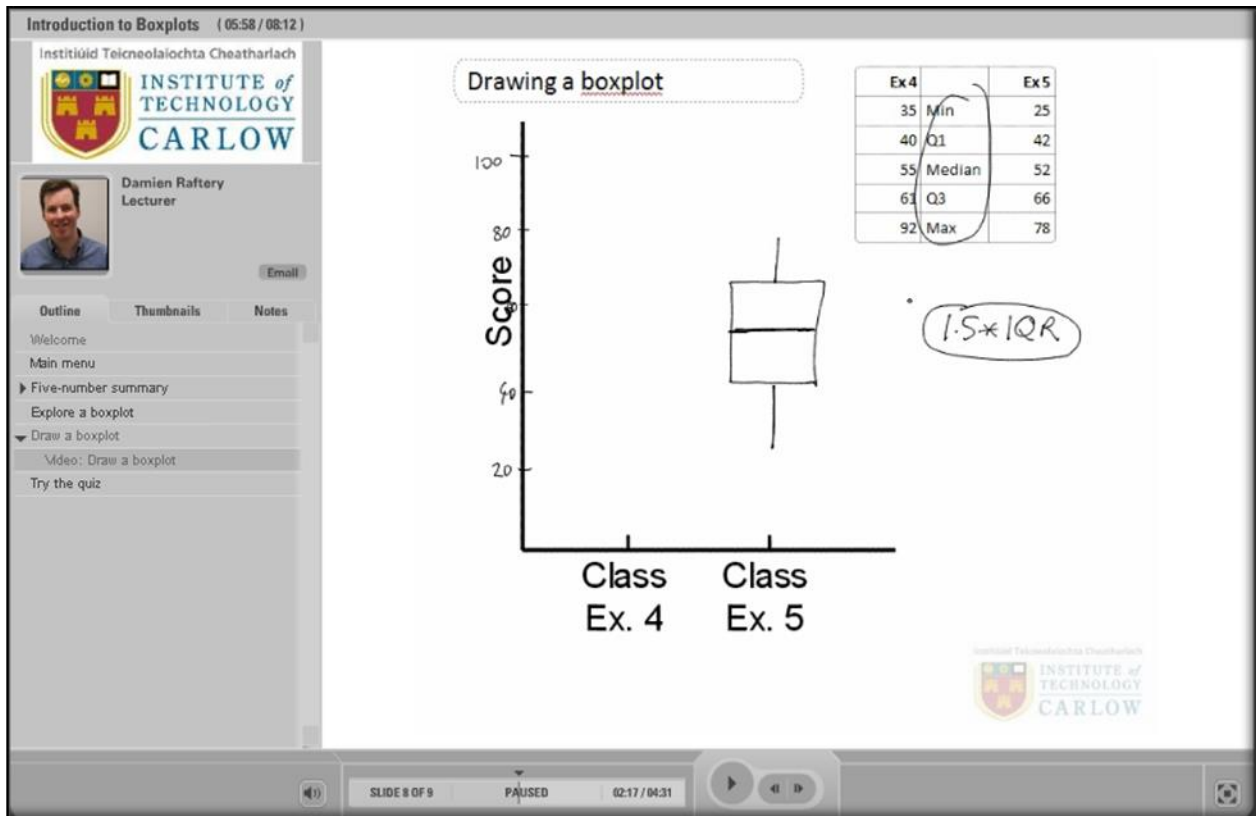


Figure 4 – screenshot from *Introduction to Boxplots* online learning resource, available via <https://dspace.ndlr.ie/jspui/handle/10633/2489>

Students found the online presentations useful, with over three quarters finding useful the online videos showing handwritten solutions with audio explanations to questions. A mature student commented: “this type of learning style is very useful.”

CONCLUSION(S)

This year, in the business quantitative techniques subject, assignments promoting quantitative literacy, online resources and a quiz were developed and undertaken. Another main focus was on encouraging meaningful engagement in a large lecture. Overall our reflections and student feedback are positive, and below is set out a plan for a second action research cycle. Lessons learnt include the need to more formally record ongoing reflections in a structured way and to get some student evaluation of specific aspects during the year closer to the time of use.

We intend to promote quantitative literacy by using written assignments, and will refine the guidelines adding the rubrics and perhaps share an example of a similar type of assignment. We also intend to address the students concerns that not enough marks were allocated to these written assignments by re-examining the allocation of marks for each of the course components for next year. It may be better for the required output for the first assignment to be a poster, used in such a way to promote peer learning.

Some lecture activities worked better than others, but it is very important to include activities for students to engage and create meaning rather than passively listen. Student-generated data created points of interest (the most discussed being the online survey question where the students estimated the lecturer's age, leading to conversations about question phrasing, outliers and averages). The short videos were also popular and helped to vary the nature and pace of the lecture.

Clickers were popular and useful in providing feedback to the lecturer in terms of the levels of understanding within the class. We intend to integrate clickers into further topics in a way that enhances peer discussion and to build on aspects of their use that worked well. It is somewhat time-consuming to use clickers, both in terms of initial room set-up at the beginning of the lecture (physically handing the clickers out and later collecting them) as well as the longer time required to explore a particular problem or question. However this time seems very well spent as students are more engaged and active. This year the clickers were used by students anonymously (meaning that the choices of the individual student were not matched to their student number/name) – it would be interesting to explore using clickers where students' choices were recorded, opening the possibility for having some questions that could be used for summative assessment.

We plan to develop more online quizzes, in both the financial maths and statistical topics. The upgrade of Blackboard will allow us more flexibility with accepting student answers and should be less frustrating for the students. We also plan to develop further online resources on important topics and difficult concepts, with greater input and feedback from students. Learning resources created using Articulate Studio are SCORM compliant and the Blackboard upgrade should allow quiz results to be tracked using the Grade Centre.

Biggs states that 'Expert teachers continually reflect on how they might teach even better' (2003, p. 6). This year, we have enjoyed teaching and innovating, and seeking student feedback and

reflecting on these innovations. Next year we continue to strive to create a learning environment conducive for our students to flourish.

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