Learner-focused Moodle quizzes for revising Mathematics and Statistics

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Summary

Web-based quizzes can be a valuable tool for providing assessment and feedback. One major advantage over paper-and-pen-based assessment is that an online system is available 24/7 giving students the flexibility to work whenever (and from wherever) they want. This advantage is especially important for a modern university which aims to attract students from a variety of diverse backgrounds, some of which are not always compatible with “classical” lecture and tutorial times.

When used for formative assessment it is imperative that an online quiz system provides the learner with detailed diagnostic feedback, in the same way a learner would expect feedback for a written work or during a tutorial. Most importantly, the learner should be given meaningful feedback at the end of a quiz session, pointing out strengths and weaknesses. A student should also have the option of customising a quiz, for example by choosing which topics to focus on. We believe that such a system helps students in revising the topics covered in a course and that providing such a system leads to improved retention and progression.

Moodle has a quiz activity and a sophisticated reporting system for summarising quiz results, however these tools are entirely focused on the teacher. The learner gets no diagnostic overall feedback. In addition, Moodle quizzes can be customised only by the teacher, not by the learner.

We propose to add these two features to Moodle, giving the learner the option of customising a quiz together with detailed diagnostic feedback at the end of a quiz session. In addition, we propose to link Moodle to subject-specific software, which allows for a more sophisticated randomisation of questions.

We intend making use of these features in many of the first and second year courses taught by the Department of Statistics. We envisage that the features will also benefit other departments making use of Moodle quizzes.

Aims and Outcomes

Our vision is to develop a quiz module that puts learners at the centre. The project aims to extend the Moodle quiz module in two ways:

- Students can be given the option of customising a quiz by selecting the number of questions, the topics to be covered, the level of difficulty, and whether the quiz should be adaptive. At an early stage, the student might prefer to focus on topics he or she is familiar with. At a later stage (especially shortly before the exam), the student might prefer the system to do the opposite and focus on topics he or she is unfamiliar with.

- At the end of a quiz session the student will be given detailed diagnostic feedback, highlighting areas in which the student has done well and areas in which the student needs to do more revision. The student will also be referred to the relevant sections of the lecture notes / textbooks (see figure below).

We expect that these two new features will greatly improve the student experience when taking quizzes in Moodle, especially when the quizzes are intended for revision. This improved student experience should result in students making increased use of quizzes, which in turn improves progression and retention.
Many questions in a question bank have the potential of being randomised (e.g. by using different numbers in a mathematical question). Randomised questions have the advantage that even if the same question has already been presented to the student, the student can still benefit from it, especially if the question refers to rather mechanical skills. The necessary randomisation strategies are often rather complex, but can typically be carried out easily using subject-specific software. We do not think that it is realistic to give Moodle itself the ability to do this. Thus we suggest linking Moodle to subject-specific software. This process would happen “at the back end”, and would not be visible to the student.

As a trial-run the system will initially be used for a second year Probability course. In the medium term we intend that many first and second year courses taught by the Department of Statistics, notably “Statistics 1C” (taught to Psychology students), “2X Probability Models”, and “2Y Regression Modeling” will make use of these new features. By the end of the project, the “improved” quiz module will be made available on the University's Moodle servers, so that all Moodle users throughout the University will be able to benefit from it.

As the project is based on extending Moodle we expect the benefits to continue to materialise once the project has finished.

**Previous Work**

**Background.** Even though many lecture courses involve tutorials, workshops, and/or computer labs, many students require additional help. In the Statistics Department this is especially the case for the courses covering Probability Theory. However, due to their diverse backgrounds, students struggle with different aspects of the course: some students struggle with the underlying Mathematics, others struggle with the applied nature of some of the material. Whilst Oxford/Cambridge-style one-to-one tutorials would in theory be a solution to such a problem, this would not be cost-effective. In addition, a web-based quiz system gives students additional flexibility, as they can use it when they want, and ideally even configure it so that it best suits their needs.

In a survey of second year Statistics students taking “2R Probability” in 2009/2010, 89% of the respondents agreed or strongly agreed with the statement that they would benefit from a web-based quiz system of revision questions. By comparison, only 48% of the students agreed or strongly agreed with the statement, that they would benefit from peer-assisted learning (PAL) sessions. Around 60% of the students responded that they would regularly use such a system continuously throughout the semester, and more than 80% would make regular use of such a system when preparing for the exam.

**Track record.** The Department of Statistics at the University of Glasgow was one of the departments pioneering the use of computers in teaching Statistics. It also has a long track record of working in Statistics Education. It has been host to part of the Statistics portion of the CTI (Computers in Teaching Initiative), LTSN (Learning and Teaching Support Network) and HEA (Higher Education Academy).

The department has vast experience both in the implementation of software for Statistics education as well as the development of content for online resources, funded by grants from the Teaching and Learning Technology Programme of the UK Higher Education Funding Councils, the JISC Distributed E-learning (DEL II) and the Higher Education Academy. Past projects include “Statistical Education Through Problem Solving” (STEPS), and the web-delivered “Model choice” and “Testing Statistics” projects.

From the outset these systems focused on providing the learner with detailed diagnostic feedback. A University of Glasgow 2008 MSc project by Karina Paterson highlighted the need for meaningful diagnostic feedback to students.

**Methodology**

This project consists of two parts: The development of a new student-focused quiz module for Moodle, followed by a short evaluation phase, in which the module will be used for “2R Probability”, a second year course taught in the Department of Statistics. We propose to split the software development required for this project into four work packages, each of which will add additional functionality to Moodle:

**Work package 1.** The first work package focuses on giving the learner detailed diagnostic feedback at the end of a quiz session. After having answered the last question students will be given a summary of their performance with a detailed breakdown according to a hierarchical collection of topics (or learning outcomes), highlighting areas in which they have done well, and highlighting learning outcomes the students have not yet achieved. Technically this will be achieved by tagging each question with one or more keywords (topics or learning outcomes). Topics (or learning outcomes) can be linked to sections of the lecture notes and/or a textbook, so students can refer to the relevant section of the lecture notes / textbook.
**Work package 2.** The second work package focuses on giving the learner more control over the quiz. Currently, a Moodle quiz is put together by the teacher, giving the student no control over the quiz. At the beginning of the quiz the student will be presented with a screen allowing the student to choose the desired number of questions and the desired difficulty of the questions. In addition the student will be given a hierarchical list of topics, from which he or she can select topics. In addition the student can choose whether the quiz should be adaptive.

**Work package 3.** The third work package develops a framework for randomizing (and checking) questions outside Moodle. This is done by passing information from Moodle to a back-end server running subject-specific software, such as GNU R or Maxima. The student will only interact with Moodle. Such an architecture is already used by the STACK quiz system for mathematical quizzes developed at the University of Birmingham. Protocols for exchanging information between a VLE and subject-specific software already exist, notably RQP and Opaque. We propose to extend these existing protocols for our needs, and providing Moodle quizzes with an interface for them.

**Work package 4.** The fourth work package consists of implementing a subject-specific back-end, which will provide Moodle with the ability to randomise questions using sophisticated statistical calculations. This back-end will focus on Statistics and thus make use of GNU R. We aim to make the implementation as portable as possible, so that it will be easy to use the back-end with other subject-specific software.

**Evaluation/Trial-Run.** The system will be tested in “2R Probability” in autumn 2011. Students will be introduced to the system in the lectures and during a workshop. The system will only be used for optional formative assessment. The effectiveness of the new system both from teacher's and the learner's point of view will be assessed. The findings will be considered when updating the implementation before the system will be advertised to other Moodle users.

We intend to obtain ethical approval once the implementation phase is finished, and before student feedback is collected.

**Potential Applicability / Transferability**

**Use by other departments.** Work packages 1 and 2 are generic and not specific to Statistics. Once installed on the University's Moodle servers, every Moodle user will be able to use customizable and adaptive quizzes giving the learner detailed diagnostic feedback. Thus we expect the entire University (and the entire Moodle community) to benefit from this part of the project.

Work package 3 develops a generic framework for interfacing Moodle with subject-specific software. Other departments teaching a quantitative subject (like Engineering, Physics, or Mathematics) might also have to resort to subject-specific software (like computer algebra systems), and thus will benefit directly from our work. Work package 4 is specific to Statistics. Whilst we do not expect this part of the project to be used by other departments of the University of Glasgow, we anticipate that it will by Statistics (and Mathematics) departments at other universities.

**Workshop.** Towards the end of the project we plan to hold a workshop offering potential users from other departments training on how to make use of the new facility.

**Commitment to Free Software.** All code will be released under a free license. We will contribute the code to the Moodle community, which we hope will help with maintaining the code to operate under future versions of Moodle.

**Support from the MSOR Subject Centre.** The Higher Education Academy Maths, Stats and OR Network will support the project by assisting in the promotion of the deliverables both within Maths and Statistics, but also across other cognate disciplines. We aim to publish results from this work in “MSOR Connections” as well as other appropriate journals.

**Evaluation**

Part of the evaluation will be by examining the student experience. In the spirit of “Web 2.0” it is intended that students should not only take part in the quizzes but also leave feedback on their experience within Moodle. We have experience of this from the “Testing Statistics” system, where the majority of students leave some form of meaningful feedback.

Starting from September 2011, “2R Probability” course will make use of this quiz system. At the end of the course, students will be given a paper-based questionnaire relating to their experience with the quiz system.
**Timetable**

September – October 2010: Developing specifications etc.

November 2010 – June 2011: Implementing the system (~2 months per work package)

July 2011 – September 2011: Populating the system with questions for “2R Probability”

September 2011 – December 2011: 2R Students make first use of the system / Evaluation

March 2012: Module made available to all users / Workshop for other departments

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**Consultation with the Learning Technology Unit**

We have consulted Mr Kerr Gardiner and Mr Niall Barr from the Learning Technology Unit. The LTU has offered to assist with some of the programming involved, which is included in the budget overleaf.

From a purely technical point of view some of first work package relates to the tagging system to be implemented as part of the LTDF funded project “A Framework for Computer-Assisted Assessment Throughout the University of Glasgow”. We hope that this overlap results in efficiency saving for both projects.

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**Related JISC bid**

We are currently in the process of preparing a complementary bid for a Learning and Teaching Innovation grant from JISC. The bid proposes to implement a Javascript-based framework for rich interactive quiz questions. Such interactive questions would for example include drag-and-drop-based interaction with plots.

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**Budget**

Dr Ludger Evers, Prof Adrian W. Bowman, and Prof John H. McColl will provide academic input and oversight. Using the new module, Dr Ludger Evers will develop questions for the second year Probability course. The cost associated with this portion of project will be borne by the department.

Dr Ludger Evers will also be coordinating the project, and will be responsible for writing specifications in collaboration with the programmers involved, as well as carrying out regular checks of the implementation and the code beneath. In order to enable Dr Evers to carry out this rôle, we suggest to reduce Dr Evers's teaching load by a small amount for two years: one short lecture course and the associated assessment / marking would then be covered by postgraduate teaching assistants (paid hourly at grade 6 (teaching) / grade 5 (marking)).

The majority of the coding will be done by Dr Ewan Crawford, who is a research fellow currently employed with funding from the Higher Education Academy. Dr Crawford has 20 years of experience of working on education-related IT projects. Most recently he is the main developer of the interactive R interface “rpanel”, and implemented both the “Model Choice” and the “Testing Statistics” systems for the Higher Education Academy. The experience of developing all three of these systems will be drawn upon in this project and this mixture of expertise is unlikely to be found elsewhere. Dr Crawford's contract currently expires on July 31st with an expected extension of five months (which we expect to be extended further). We propose to fund three months between these contracts through this LTDF grant.

Some of the programming will be contracted out to the Learning Technology unit (with Mr Niall Barr as key contact). We are planning to contract out around 25 days of programming work.

The department will bear the cost of providing a server onto which a development copy of Moodle can be installed.

**Salary cost:**

- Buy-in of Dr. Ewan Crawford (grade 8) £13608.75
- 3 months à £4536.25 / month

**Input from University Services:**

- Buy-in of a postgraduate teaching assistant (£1000 / year) £2000.00
- Learning Technology Unit (Mr Niall Barr) £4235.25
- 25 days à £169.41 / day

**TOTAL** £19844.00

Should this application be successful and be granted funding, I give consent for this application to be published on the Learning and Teaching Centre website.

Ludger Evers, Project Leader
1 April 2010

Learning and Teaching Development Fund 2010

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I am writing to confirm that the above bid has my full support, as Head of Department.

I can also confirm that ethical approval, if deemed necessary, will be obtained from the Faculty Ethics Committee.

John H. McColl
Head of Department

Professor E M Scott
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