Enhancing the Learning Experience on Programming-focused Courses via Electronic Assessment Tools

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TFPIE17: Trends in Functional Programming in Education

A Pedagogic Case for the Use of E-exams

- Improve *feedback:* use formative e-exams to provide immediate feedback to students and provide a *checkpoint* of their progress
- Improve *student engagement:* exams and tests are peak times of student engagement;
- *Programming courses are ill-suited for paper-based exams*
- Counter-balance classic *coursework* (for deep learning) with regular *e-class-tests* for basic knowledge checks ("threshold knowledge")
- E-exams help matching questions/tasks to learning objectives, and allow to develop a portfolio of questions

[0] https://blogs.pjjk.net/phil/requirements-online-exam-system/

Wider Rationale for E-exams

- Deal with *large first-year programming courses* and reduce the amount of (manual) marking
- Use a model that *scales* to several campuses (Edinburgh, Dubai; Malaysia?)
- Support *supervised distance learning* as well (Graduate Level Apprenticeships; new!)
- Analyse the exam results to detect trends
- Give *immediate feedback* to students on tests and quizzes
- *Increasing student engagement* and providing checkpoints of learning progress for the students;

Requirements

Core requirements for the exam software are:

- *security*: providing a lock-down client
- *reliability*: tested in various settings and on a large scale
- *scalability*: caters for large classes and different campuses

A partial solution: BTL Surpass

- The flagship product by BTL for both *summative and formative exams* (http://www.btl.com/surpass/)
- Used on large classes (hundreds of students)
- Used across several learning domains
- Good support of the workflow from course design to statistical evaluation of the results
- Already used at Heriot-Watt for overseas exams (in Business)
- A range of question styles, from multiple-choice to fill-in-the-blank
- Provides a *secure, lock-down client*

Courses

- *"Software Development 1"* (Year 1, Semester 1): introductory Java programming;
  - large class size;
  - mainly summative assessment;
  - high stakes exam
- *"Hardware-Software Interface"* (Year 2, Semester 2): systems programming in C and ARM Assembler;
  - challenging for students;
  - sizable coursework is daunting to students;
  - $\Longrightarrow$ provide checkpoints (formative tests, mock exam)
- *"Distributed and Parallel Programming"* (Year 4, Semester 2): a range of different parallel programming technologies;
  - students struggle with the number of technologies;
  - appreciation of relative ease of programming in a high-level language;
  - provides a step-change in learning prg langs

Using e-exams in software development courses

Results from using BTL Surpass in a *summative exams* in "Software Development 1"[1]:

	1	2	3	4	5
I was able to demonstrate whether I understood the material being tested.	1	2	12	*25*	19
I felt adequately prepared to use the software.	1	4	8	*24*	23
I found the software used to deliver the exam easy to use.	0	2	7	14	*37*
I was able to enter the answers that I wanted to.	1	1	6	12	*40*
The feedback from the software about whether my answers had been submitted was adequate.	0	5	12	20	*23*
The computer lab was a suitable setting for this exam	1	4	10	13	*32*

[1] results from 60 out of 150 students; on a 1–5 likert scale

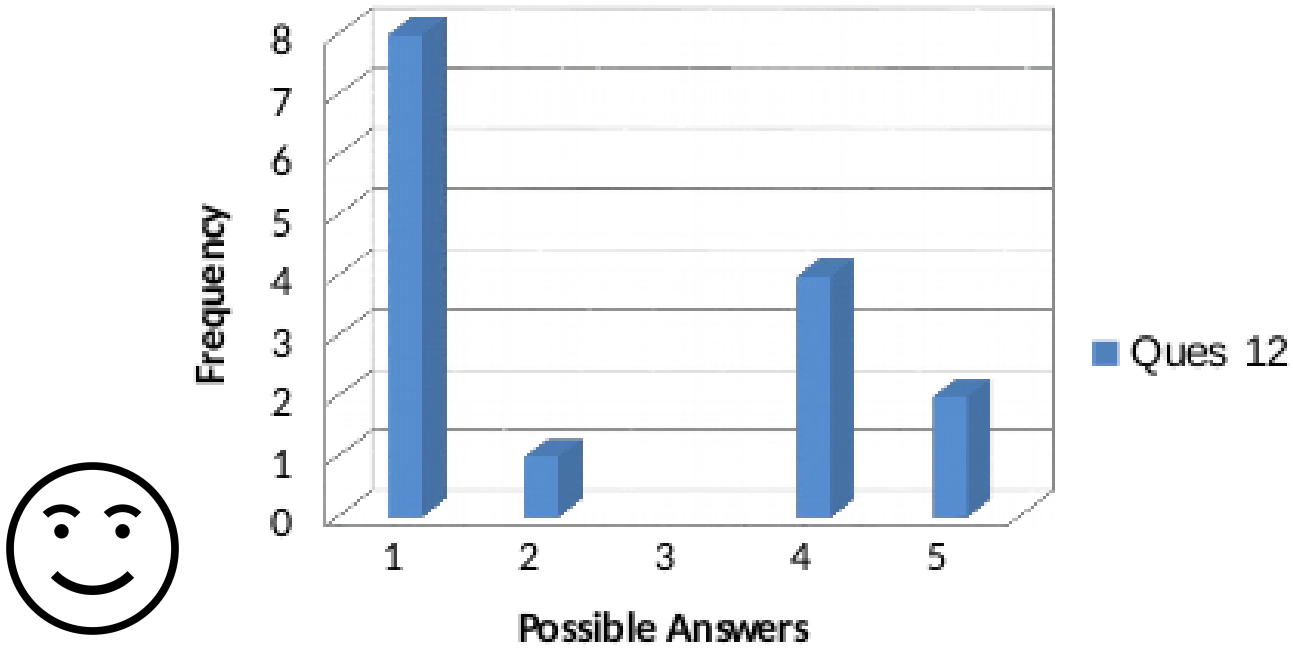
More results and Student responses

- Highest strongly agree (42 strongly agree, 7 agree, out of 50) was on *"I would like to be able to self-assess for practice while studying"*
- with a desire expressed for *"immediate automatic feedback on my performance"* (44 strongly agree, 10 agree).
- From interviews
  - easier and less stress-ful to work with an on-line system rather than paper-based exams
  - useful to flag questions during the exam
  - useful to have a timer on screen

Results on Feedback

These results are from a *mock exam on "Hardware Software Interface"* involving 12 students.

Self-assessment: *I would like to be able to self-assess for practice while studying*

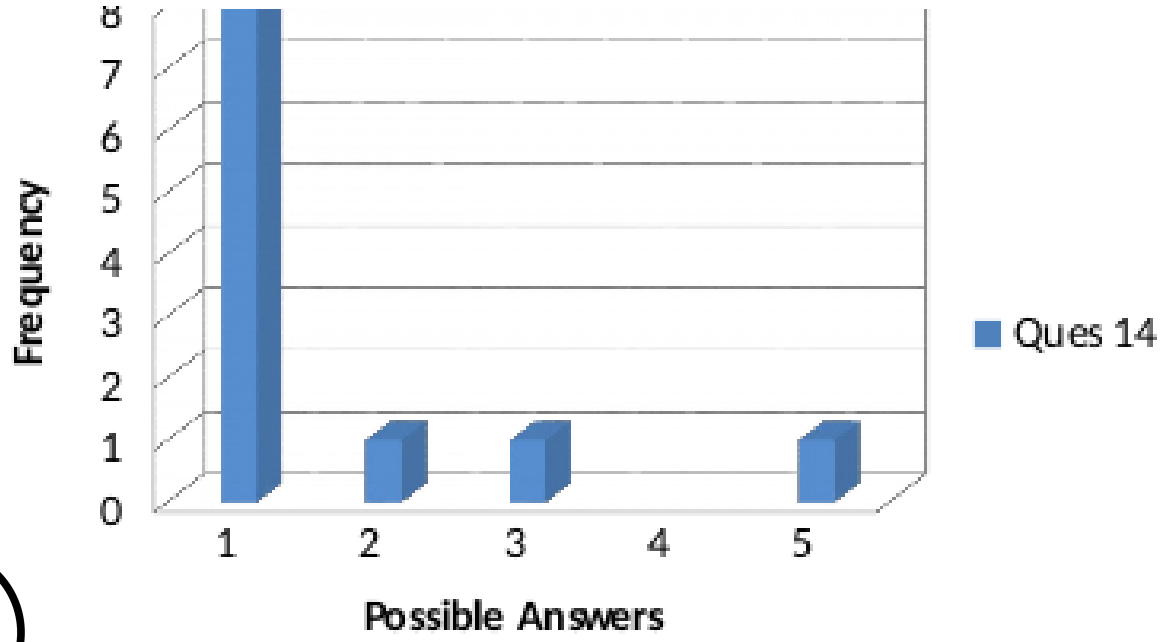


[1] *Note*: results on a *reverse* 1–5 likert scale, i.e. 1=strong agree

[1] Pictures from https://openclipart.org/

Results on Feedback

Immediate feedback: ***I find immediate automatic feedback on my performance really useful.***



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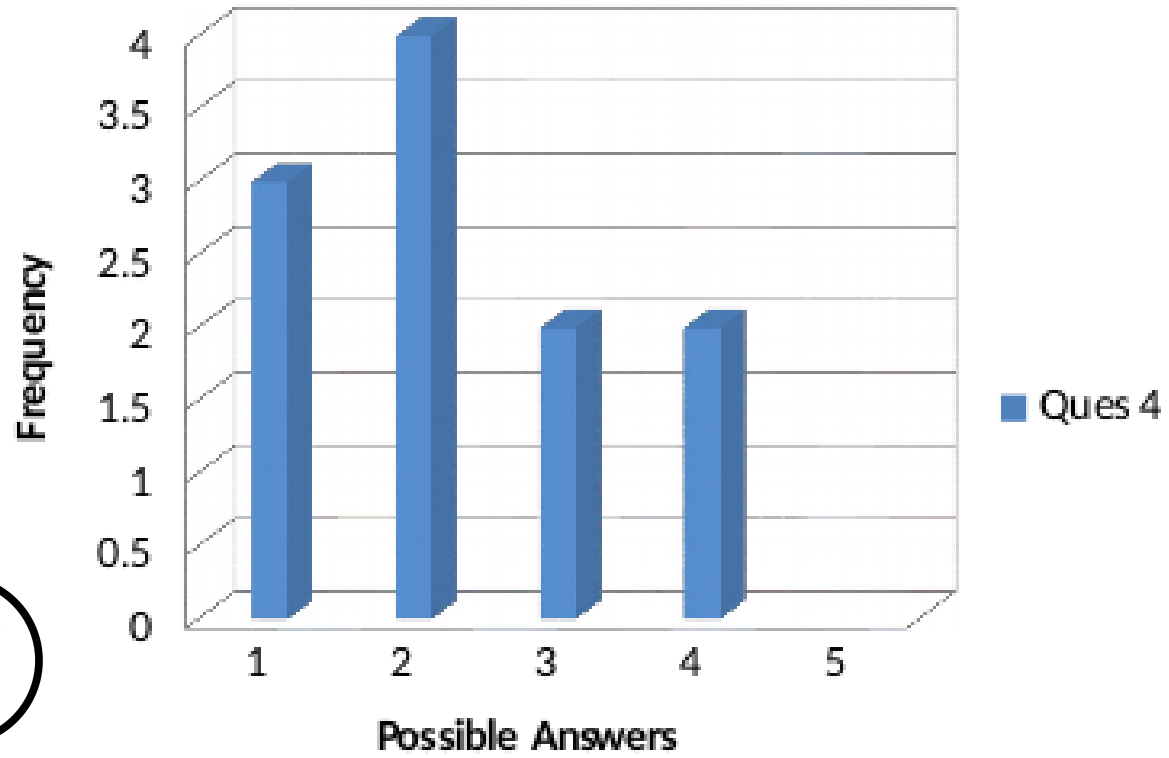
Results on Usability

Understanding: ***I was able to demonstrate whether I understood the material being tested.***



[1] *Note*: results on a *reverse* 1–5 likert scale, i.e. 1=strong agree

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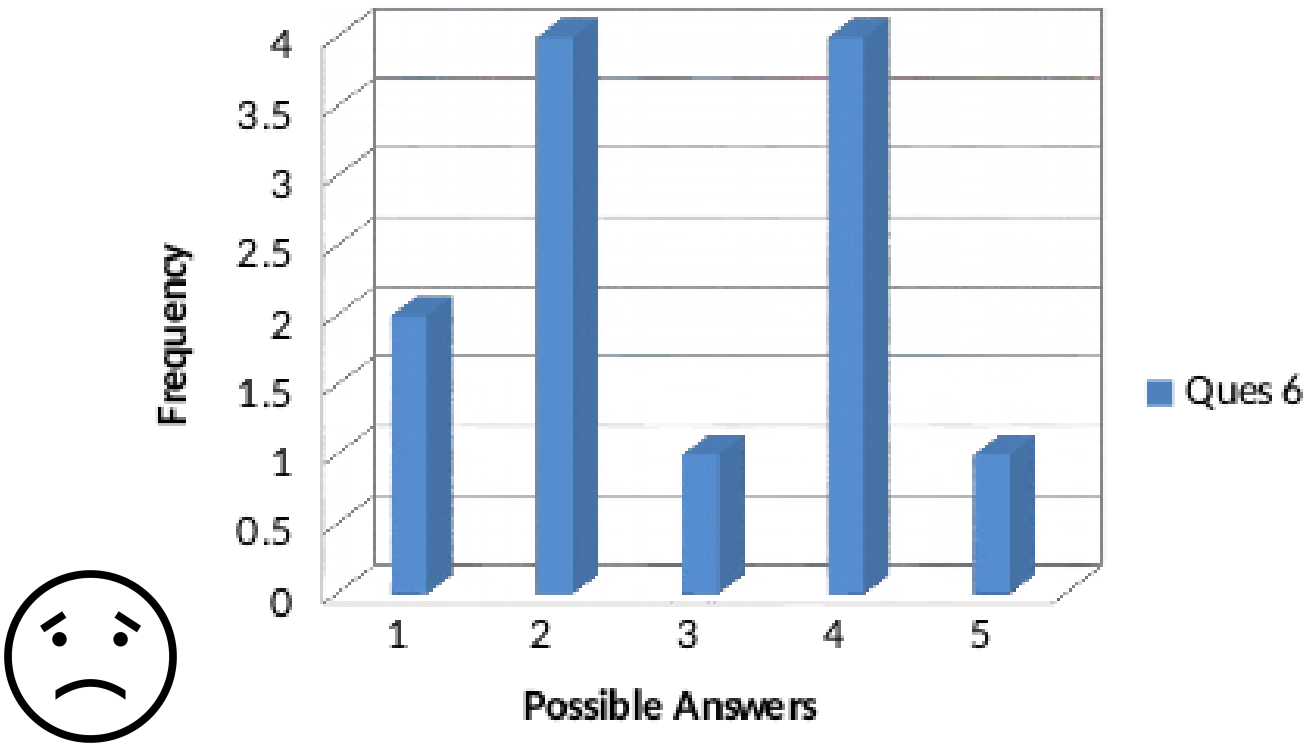
Results on Usability

Ease-of-use: ***I found the software used to deliver the exam easy to use.***



[1] *Note*: results on a *reverse* 1–5 likert scale, i.e. 1=strong agree

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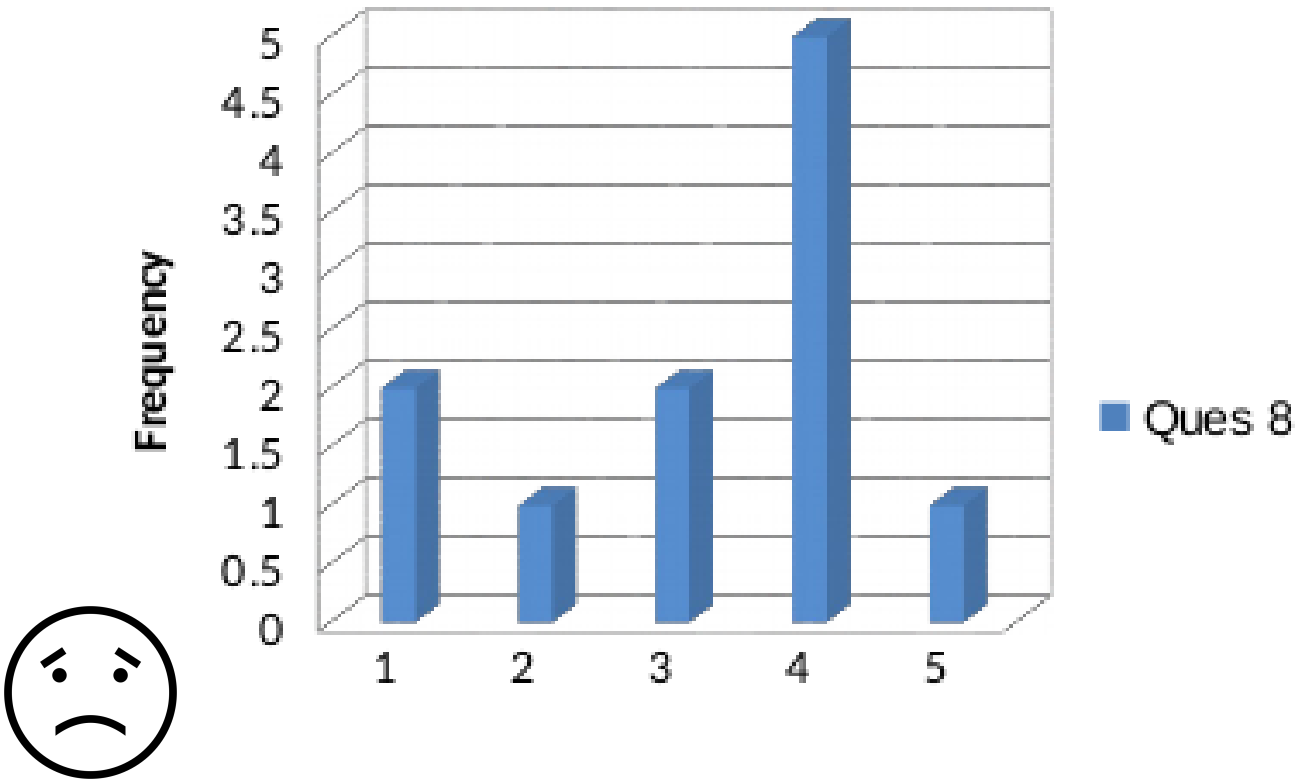
Results on Usability

Lab: ***The computer lab was a suitable setting for this exam.***



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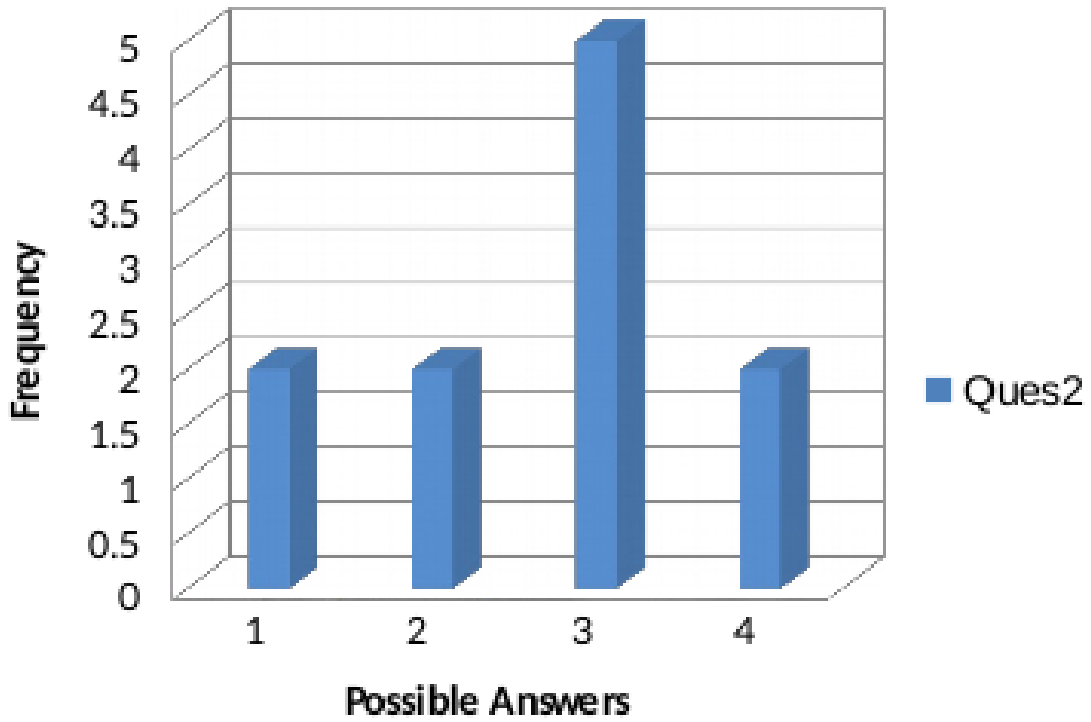
Results on Usability

Overall satisfaction: ***Overall, were you happy with the software that was used during your previous online assessment?***



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Conclusions

- Coding skills can be effectively tested in an e-exam setting
- Students like immediate feedback (on quizzes and e-exams)
- Mixed from results second year course: very positive on issues of "immediate feedback", but negative on some usability issues
- Potential for usage in fourth year: the step-change in learning a functional programming paradigm needs a mixture of lecture-style presentations (use e-tests for "threshold knowledge") with practical coding exercise (MOOC style)

Some Practical Lessons

- Don't make the a "high-stake exam" the first meeting point of student and software
- Manage the student's expectations
- Pay attention to logistics around setting up the exam: login data, lab setup (and space), lab helpers
- Know the system well enough to deal with hiccups
- Make sure to have on-site technical support

Related Work

- *Coderunner:* run and test code submitted by students; supports many different languages; implemented as a Moodle plug-in
- *Coding Bat:* intended only for small scale coding practice, but might still be useful
- *STACK:* computer aided assessment of mathematics, using an open-source computer algebra system underneath; implemented as a Moodle plug-in
- *The Great Courses:* this is a commercial site that provides video lectures for a lay audience; notable for the high quality of lecture presentations