

EXTENDING AWESOME

Final Report for CS39440 Major Project

Author:

Benjamin BROOKS
beb12@aber.ac.uk

Supervisor:

Dr. Hannah DEE
hmd1@aber.ac.uk

Thursday 7th May, 2015

This report was submitted as partial fulfilment
of a BSc degree in Computer Science
(inc Integrated Industrial and Professional Training) [G401]



Department of Computer Science, Aberystwyth University
Aberystwyth, Ceredigion, SY23 3DB, Wales, UK

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In signing below, I hereby agree to this dissertation being made available to other students and academic staff of the Aberystwyth Computer Science Department.

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Ethics Form Application Number

The Ethics Form Application Number for this project is: **1019**.

Student Number



110059875

Many thanks to my supervisor Hannah Dee for the guidance and support throughout this project; Sandy for providing a server, and support when it went wrong; and the rest of the staff at Aberystwyth University for the countless hours they put into making it an outstanding place to study.

Thanks to Gareth Williams for providing better Welsh translations than Google Translate ever could, and thanks Keiron O'Shea for the AWESOME prototype upon which this project is based.

Thank you to my fellow classmates, flatmates, friends, and family for the continued motivation, ideas, and encouragement; not only over the past few months, but also the past four years through my university course.

But most of all thank you to Bethany Foskett, for being there with sugary snacks, caffeinated beverages, and occasionally being my rubber duck [1].

Abstract

The Aberystwyth Web Evaluation Of Module Experiences (AWESOME) is a tool used to evaluate the performance and quality of teaching of modules at Aberystwyth University. The aims of this project are to ensure the prototype version of AWESOME is security audited, refactored to use better programming practices, fully functioning, and is deployed to capture module evaluation data.

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List of Acronyms

ASTRA Aberystwyth Student Records and Admissions

AU Aberystwyth University

AWESOME The Aberystwyth Web Evaluation Of Module Experiences

CI Continous Integration

i18n Internationalisation

MEQ Module Evaluation Questionnaires

MVC Model-view-controller

OOP Object-oriented programming

SME Student Module Evaluation

CSV Comma-Separated Values

PDO PHP Data Objects

SQL Structured Query Language

RDBMS Relational Database Management System

1. Background & Objectives

1.1. Introduction

The Aberystwyth Web Evaluation Of Module Experiences (AWESOME) is a web-based tool that enables departments to generate personalised questionnaires that get sent out to students to gather feedback about modules, lecturers, or even events such as BCS Show & Tell¹ and other talks.

1.2. Background

Departments at Aberystwyth currently have no formalised process of gathering student feedback unlike many other universities. The University of Sussex requires courses to be evaluated through their Module Evaluation Questionnaires (MEQ) [2] which contains seven core quantitative questions and up to ten additional questions at the school-level, module-level or a mixture of both. The University of Westminster have Student Module Evaluation (SME) [3], which is an online questionnaire containing ten questions per module sent via e-mail about modules. There are many other similar examples of module evaluation systems across UK universities, with their main features being personalised, anonymised, and incentivising completion.

At Aberystwyth, some departments such as Geography & Earth Science, and English choose to hand out paper-based questionnaires in lectures for each module a student does. Having a student take multiple questionnaires to provide essential feedback can lead to many issues due to survey fatigue. This can significantly reduce response rates and also have an impact on the answers students provide. The Computer Science department has tried many methods of collecting module feedback with varying successes which will be elaborated upon in subsection 1.2.1.

AWESOME was originally proposed and developed under the Learning and Teaching Enhancement Fund by Dr. Hannah Dee, and work on the prototype was undertaken by Keiron O'Shea. The project was selected as my dissertation project to extend and implement.

¹BCS Mid Wales Show & Tell: <http://midwales.bcs.org/show-and-tell-events>

Several meetings by the Learning and Teaching Enhancement Committee and Pro-Vice-Chancellor Professor J. Grattan took place to discuss the future of AWESOME and the need for a module evaluation system used university-wide and talks are still ongoing.

1.2.1. Module Evaluation Method Analysis

There are several important factors to consider when collecting module evaluation feedback. First and foremost, responses must be anonymised, secondly being able to provide incentives for completion drastically increases response rates. Being able to have students complete the survey in their own time, and also send targeted reminders to complete the survey are also important. If reminders are constantly being sent to students who have already completed the survey, they are likely to get frustrated or annoyed and are less likely to notice another survey e-mail. Consolidated surveys help with fatigue, as students only have to answer one survey. There have been several studies on how survey fatigue affects response rates and poor answer quality [4]. This consolidation only works if the surveys are personalised, as seen from Google Forms response rates in Table 1.1, students are lazy, and they will not skip over modules if asked to.

Table 1.1 shows a feature comparison of current methods of module evaluation at Aberystwyth University and corresponding response rates.

Paper based module feedback during lecture time can have effective response rates because lecture-time is set aside to complete questionnaires. However students usually have to complete one questionnaire per module which can lead to fatigue very quickly.

Qwizdom² is a hardware-based voting system, with 'clickers' handed to students in a lecture who can then cast their votes through a powerpoint style questionnaire. Response rates for Qwizdom module evaluations are high for the same reasons as paper based forms. Students are stuck in a lecture for an hour with nothing else to do. One problem Qwizdom does give, is that answers can only be quantitative and not qualitative. Students can't easily input textual comments through Qwizdom so a lot of valuable information is not gathered from students.

Google Forms has been the standard way of running module evaluation questionnaires for the past few years in CompSci. Google Forms provides anonymous answering in the student's own time and can also provide a way of gathering valuable textual comments. One disadvantage of using Google Forms is that there is no way of knowing which modules a student

²Qwizdom Homepage: <http://qwizdom.com/higher-education/home>

is enrolled for, so students have to skip over modules that aren't applicable. This makes the survey confusing and error prone at times and response rates suffer as a result.

AWESOME has been created from the ground-up to address all of these problems. Responses are anonymised, while retaining the ability to see who has, and has not completed the questionnaire yet. This allows for targeted reminders and incentives for completing the survey. Additionally, AWESOME imports data directly from Aberystwyth Student Records and Admissions (ASTRA) which allows all student, staff, and module data to be easily used without lots of manual data entry. This also allows for personalised surveys, asking questions only relevant to modules a particular student is enrolled for. By collecting both Quantitative and Qualitative data, AWESOME can run advanced analytics can be run on the data gathered. The questionnaires sent out are also fully responsive, working on phones to tablets, and to desktop computers by utilising Bootstrap and can be completed at any time by the student.

Method	Tailored Questions	Anonymous	Qualitative	Quantitative	Incentives for completion	Completion on own time	Targeted reminders	Responsive	Consolidated	Response Rate
Paper	✗	†	✓	‡	✓	✗	-	-	✗	75% ^[5]
Qwizdom	✗	✓	✗	✓	✓	✗	-	✓	✗	50% ^[5]
Google Forms	✗	✓	✓	✓	✗	✓	✗	✓	✓	20%
AWESOME	✓	✓	✓	✓	✓	✓	✓	✓	✓	TBC

† Anonymity may be compromised when completing paper-based form.

Table 1.1.: Module Evaluation methods at Aberystwyth University

‡ Manual processing is required in order to analyse the data.

²Bootstrap Homepage: <http://getbootstrap.com>

1.3. Objectives

The overall objective of the project is to implement AWESOME on the Aberystwyth University network and collect module feedback for the Computer Science department.

This can be broken down into four main aims:

- **Security Audit the AWESOME prototype.** This was a large issue, as there were known security flaws with the prototype and it needed to be looked at immediately before any other work took place.
- **Bring the prototype up to modern development standards.** The program was known to be written in a procedural style, and the security audit brought up the poor Internationalisation (i18n) implementation too.
- **Finish any incomplete functionality.** Many areas of the prototype were half-implemented, but not fully completed. These had to be done before it was useable by students and staff.
- **Run AWESOME on a departmental server.** The main objective was to get a survey sent out to students and collect real-world data. This is the final step in that process.

2. Requirements

2.1. Features

The following feature list is the one proposed for the AWESOME prototype. The project follows this feature set as a baseline set of requirements.

- **Automatic questionnaire generation per-student** - Generate unique questionnaires per-student, depending on their modules and lecturers.
- **The ability to generate quick mid-term questionnaires** - A one question per module survey with a one to five scale from ‘This module is going well’ to ‘This module has problems’.
- **No need to type in registration details** - Import of module registration data via ASTRA Comma-Separated Values (CSV) export.
- **Targeted follow-up reminder emails** - Only send reminder emails to respondents who have yet to complete their questionnaire.
- **Anonymous responses** - Ability to know which particular student has, or has not completed the questionnaire, but not who has said what.
- **Visually appealing analytics** - Reports available to staff on a by-module, by-department, and by-scheme basis, with graphs and textual responses laid out nicely.

2.2. Development Practices

AWESOME should be developed using Object-oriented programming (OOP) practices if it is to be maintainable by other developers after the project is over. Internationalisation should be easily extensible and translation strings should be easy to add. Additionally, unit testing is vital if the application is going to be extended further and refactored at a later date for any reason.

2.3. User Roles

The user roles in AWESOME are quite simple, there is only an admin and a respondent and each one can only do a few tasks.

- **Admin** - The person who creates the surveys, adds questions, and sends them. They can also view results and see who has not yet completed the questionnaire.
- **Respondent** - The recipient of a questionnaire email who fills it in and submits answers. They can also submit feedback about AWESOME if debug mode is enabled.

2.3.1. Use Cases

Admin User Role

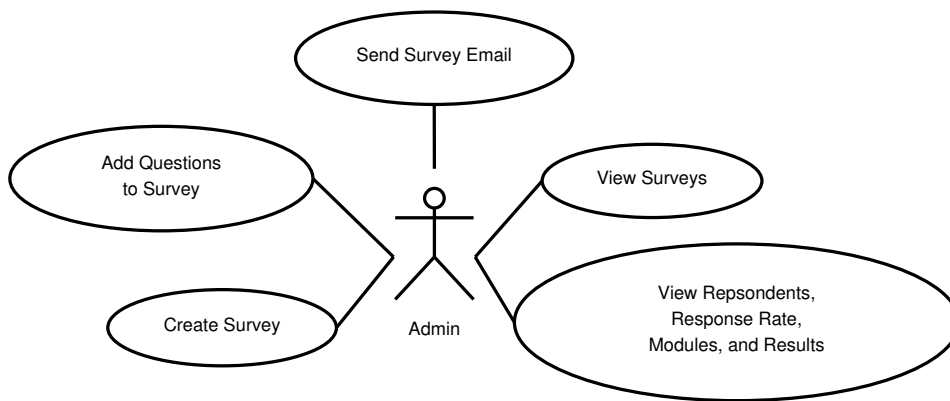


Figure 2.1.: Admin use-case diagram.

Figure 2.1 shows that admins can view surveys, create surveys, add questions to surveys, view more detail about survey such as respondents, response rate, modules, and results. They can also send an email to respondents to remind them to fill in the questionnaire.

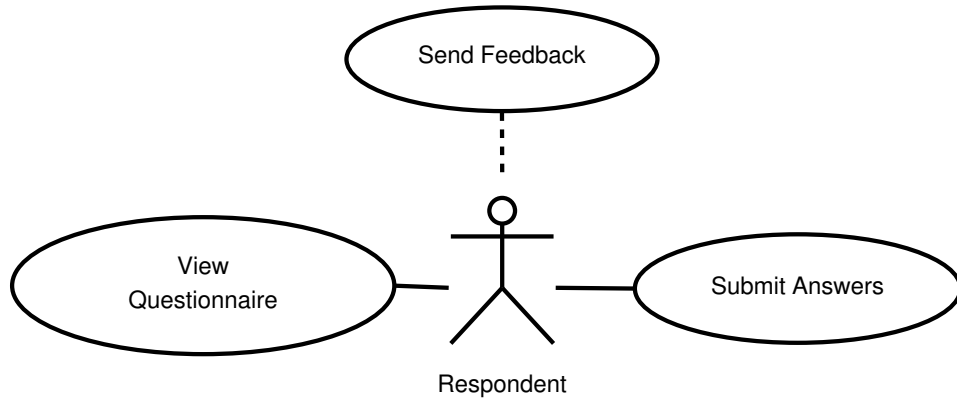
Respondent User Role

Figure 2.2.: Respondent use-case diagram.

section 2.3.1 shows that a respondent only has one responsibility in the system, and that is to respond to a survey through a link sent via email. They can only respond once, and submitted answers cannot be seen as it would break the irreversible anonymity of the system.

3. Design

After the security audit, it was apparent that the majority of the codebase needed to be refactored in order to make it object-oriented. The decision to rewrite the program was not a light one, by rewriting the program, the scope of extensions to AWESOME became much more limited via time constraints.

With the rewrite came the opportunity to utilise both a framework and a design pattern. Frameworks were ruled out under the stance that it had to be deployed on a server without shell access. However later research discovered that this is achievable in Laravel¹, which would have been the framework of choice for several reasons.

Laravel would have provided a complete, and mature Model-view-controller (MVC) framework, as well as an i18n framework and a solid basis for AWESOME. Ultimately, poor research into Laravel on a shell-less server resulted in an attempt to produce a bespoke MVC framework, which, unsurprisingly is harder than it first seems.

3.1. Programming Language

The programming language choice was fairly fixed, as it had to be easily runnable on an Aberystwyth University (AU) server. This limited the choice to PHP, but which minor version of PHP was only found out later in the project which is discussed further in section 4.1.

If this requirement wasn't an issue, Ruby on Rails would have been the ideal candidate for this project, as it already provides an MVC framework and gems for i18n.

3.2. Model-view-controller Framework

Since using a framework was ruled out, a custom-made MVC framework was written to support this project. The design of which is laid out in

¹Laravel Homepage: <http://laravel.com>

this section and is very heavily taken from the ‘Write your own PHP MVC Framework’ series of tutorials[6].

3.2.1. Routing

URL Routing is a way to access specific controllers and views from a URL. This works via an Apache rewrite rule, which appends a `$_GET` variable which contains the current requested URL.

3.2.2. Directory Structure

Figure 3.1 shows the directory structure of the MVC framework. ‘*src*’ is the source code to the program. Inside it contains everything needed to run AWESOME. Inside ‘*tests*’ are the unit tests to be run automatically by TravisCI and PHPUnit.

‘*src/app*’ has the MVC classes which are used when the routing engine rewrites URLs. ‘*src/config*’ contains the config file for the program. In this file, database credentials are set, as well as SMTP mail server settings, some i18n settings, and the debug flag which displays errors and shows a feedback form/notice (See Figure 3.8).

‘*src/db*’ is a directory for Structured Query Language (SQL) dumps for the database schema. ‘*src/i18n*’ contains translation files for the i18n framework, but more detail is in section 3.3

‘*src/lib*’ is the ‘glue’ that holds the MVC framework together. It contains the autoloader class, the bootstrap script and the third-party, open source PHPMailer[7] classes used for sending mail via SMTP.

‘*src/logs*’ is where any PHP errors get logged when debug mode is off. This is in order to hide any potential security issues with displaying errors.

‘*src/public*’ is the main entry point to the program and where the Apache vhost will be set. ‘*src/public/assets*’ contains the Javascript, SASS, CSS, and images used in the HTML. Users with a valid token will be taken to their corresponding questionnaire. ‘*src/public/admin*’ is protected by HTTP authentication to prevent anybody from creating surveys and sending them out, or reading the results of previous surveys.

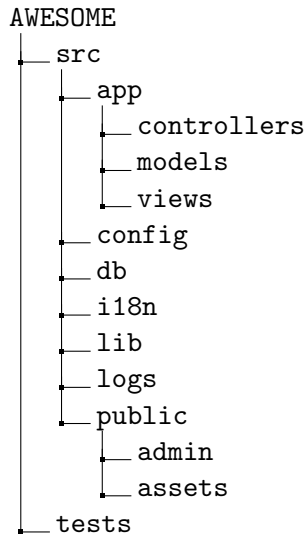


Figure 3.1.: Directory structure of the MVC Framework

3.3. Internationalisation Framework

The i18n framework is a standalone OOP module which utilises JSON formatted files with strings for translation.

3.4. Database Schema

The database schema (see Figure 3.2) used is very similar to the prototype version. Documentation needed to be written for the existing schema, so the opportunity was taken to make some changes in the structure of the database before this happened. The old database schema did not use any foreign key constraints, nor was the use of primary keys ideal.

Foreign keys are very useful to have in a system like this, as orphaned rows can be cleaned up nicely with a cascade delete. This prevents any data remaining in the table incase it is missed by an SQL query that hasn't been updated in the code.

I also made some changes to the way things were named, mostly to prevent confusion. In the new schema, a survey is a set of questionnaires, each of which is tailored to a specific student. In the old schema, everything was called a questionnaire, which led to confusion between a group of questionnaires and a single questionnaire.

Additional changes need to be made in order for AWESOME to support multiple departments across the university, but this is out of the scope of the dissertation, although this feature is on the roadmap if AWESOME is to be used university-wide.

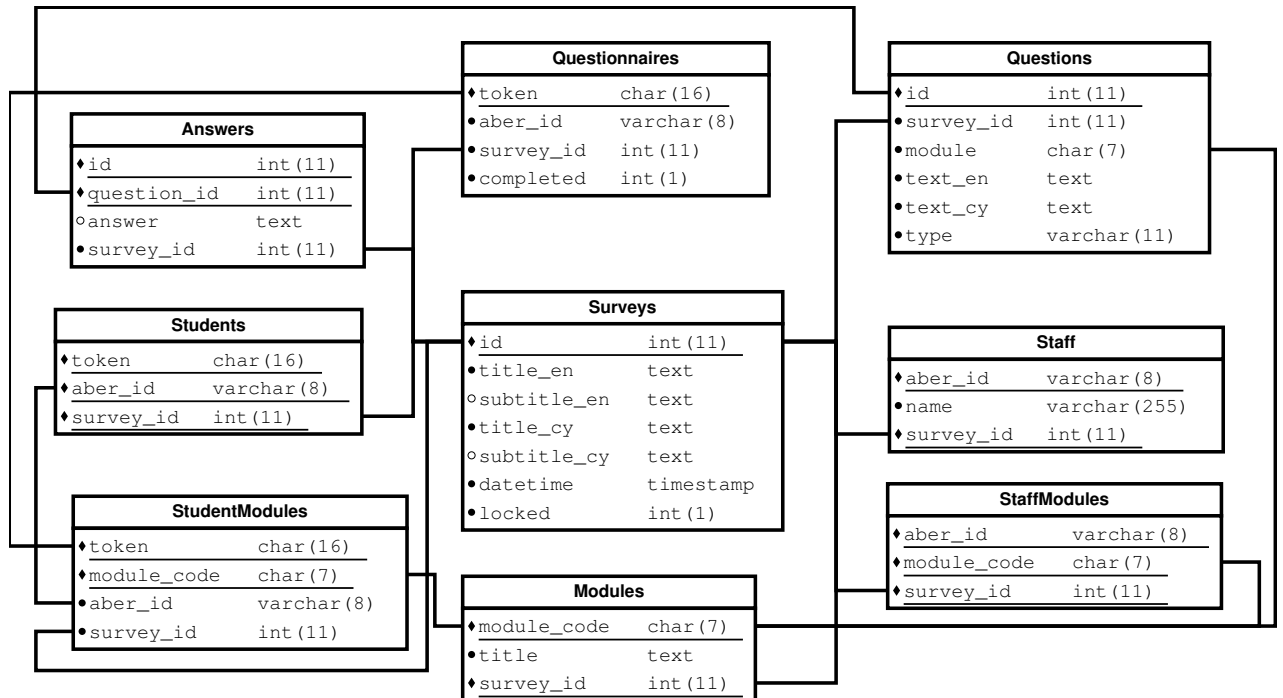


Figure 3.2.: AWESOME database schema design.

3.5. User Interface

The user interface was fairly good on the questionnaire-side in the prototype, so a lot of elements were re-used in that, with a few minor changes.

Figure 3.3 shows a comparison between the prototype version and the submitted version of AWESOME.

The figure shows two screenshots of a web-based questionnaire interface. The top screenshot is a prototype version, and the bottom screenshot is the submitted version of AWESOME.

Top Screenshot (Prototype):

- Header: AWESOME logo.
- Text: "This is a survey that's aimed at you. Once you press submit, your answers come back to us with no identifying information, and your unique link will stop working. The results are completely anonymous, so be as honest as you can!"
- Title: CS22120: The Software Development Life Cycle
- Question 1: "I have learned a good deal from this module". Rating scale: 1 (Strongly Disagree) to 5 (Strongly Agree).
- Question 2: "This module was well taught by Bernie Tiddeman". Rating scale: 1 (Strongly Disagree) to 5 (Strongly Agree).
- Question 3: "This module was well taught by Chris Price". Rating scale: 1 (Strongly Disagree) to 5 (Strongly Agree).
- Question 4: "This module was well taught by Dave Price". Rating scale: 1 (Strongly Disagree) to 5 (Strongly Agree).
- Question 5: "What one thing would you change to improve this module, and why?". Text input field with "(Optional)" placeholder.

Bottom Screenshot (Submitted Version):

- Header: AWESOME logo, Feedback button, About button, English (en) dropdown.
- Notification: "AWESOME is currently in testing! If you encounter any problems or want to leave feedback...hit the Feedback button above."
- Title: Evaluation of Semester 2 Modules y3
- Question 1: "This is a new system. Do you like it?". Rating scale: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree.
- Question 2: "Please add any further comments here". Text input field.
- Section: CS38220 - Professional Issues in the Computing Industry
- Question 3: "Frank Bott taught this module well". Rating scale: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree.
- Question 4: "Rhys Parry taught this module well". Rating scale: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree.
- Question 5: "I have learned a good deal from this module". Rating scale: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree.
- Question 6: "Please add any further comments on this module below". Text input field.
- Question 7: "What one thing would you change to improve this module, and why?". Text input field.

Figure 3.3.: A comparison of questionnaire pages between the prototype version and the submitted version of AWESOME

The admin dashboard of the prototype wasn't very user friendly. Creating surveys, adding questions, modules, students, and staff was fairly convoluted. Results weren't clear to look at, and took up a lot of space per question by pie charts, which were unnecessary given the data provided.

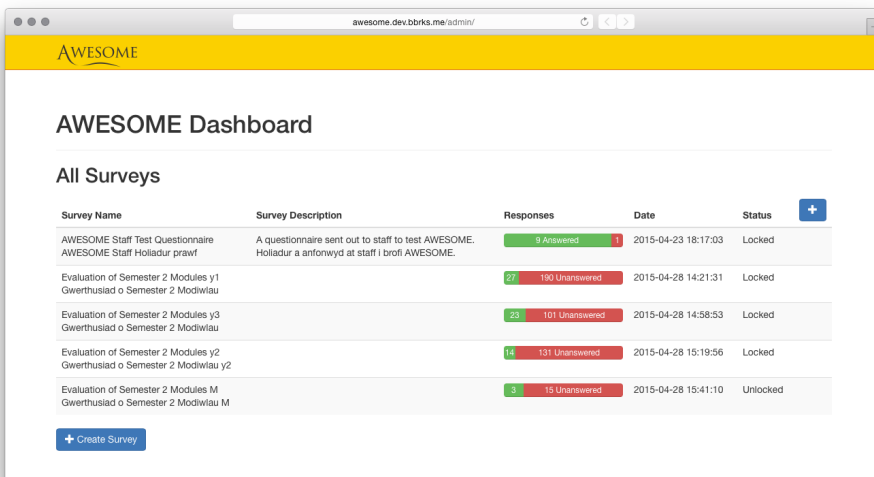
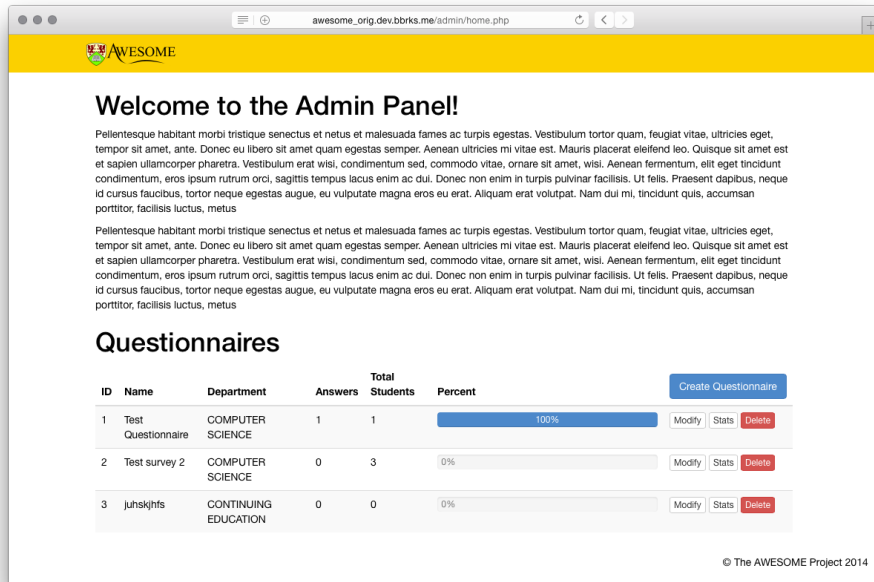


Figure 3.4.: A comparison of surveys view between the prototype version and the submitted version of AWESOME

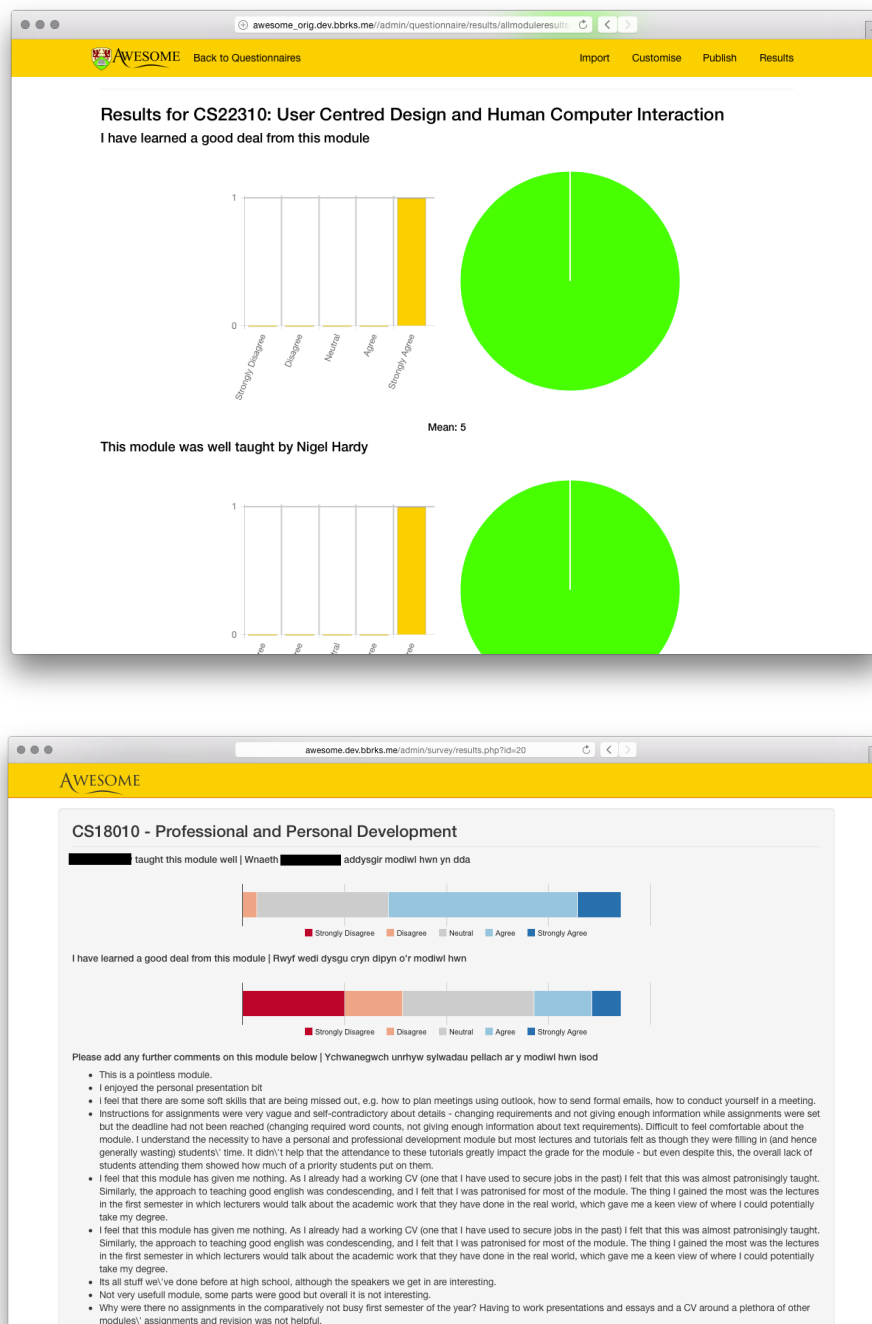


Figure 3.5.: A comparison of results between the prototype version and the submitted version of AWESOME

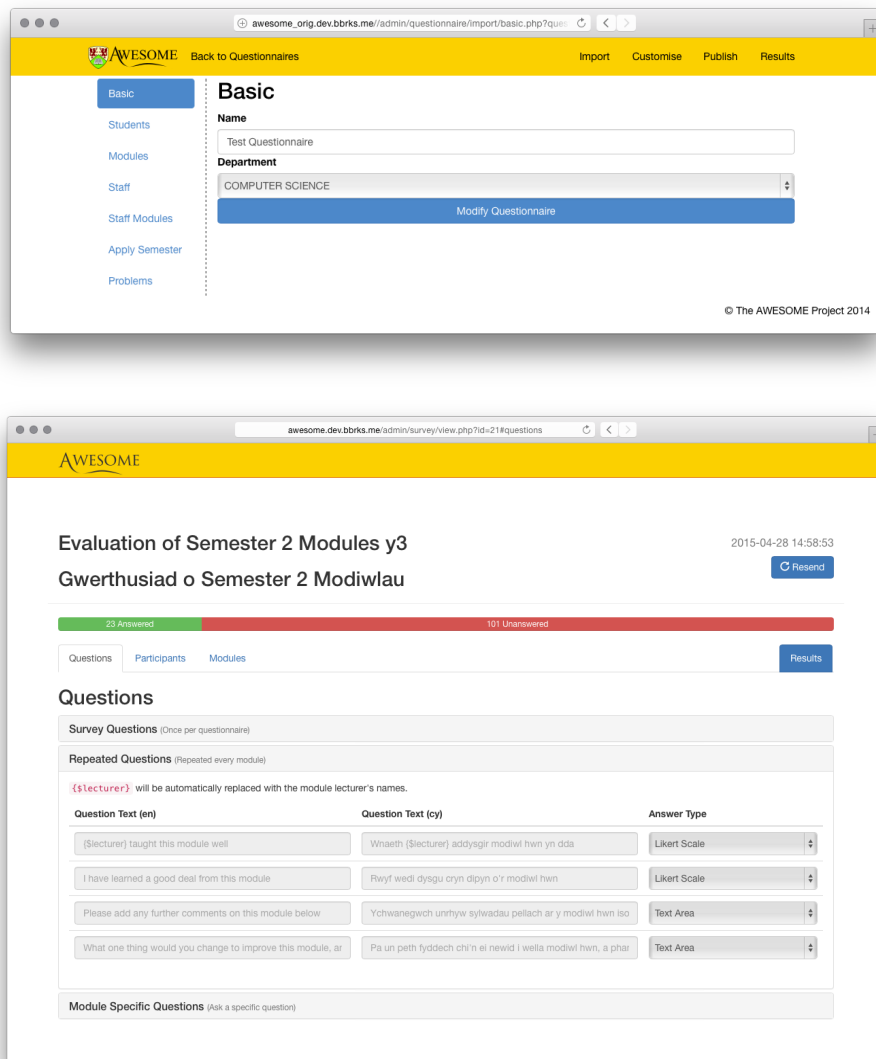


Figure 3.6.: A comparison of survey view between the prototype version and the submitted version of AWESOME

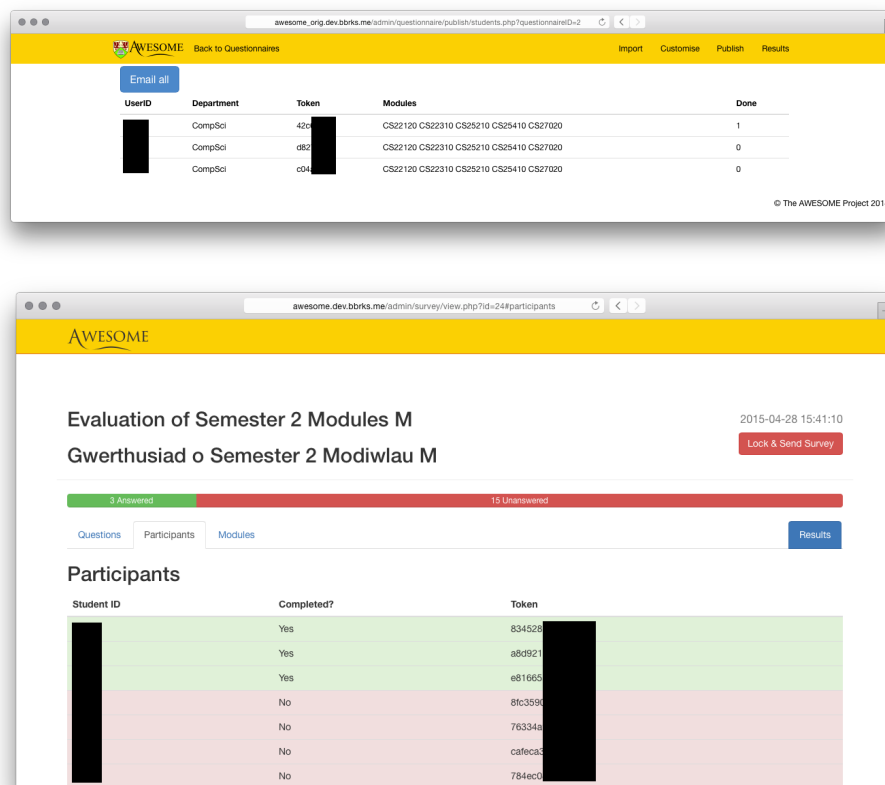
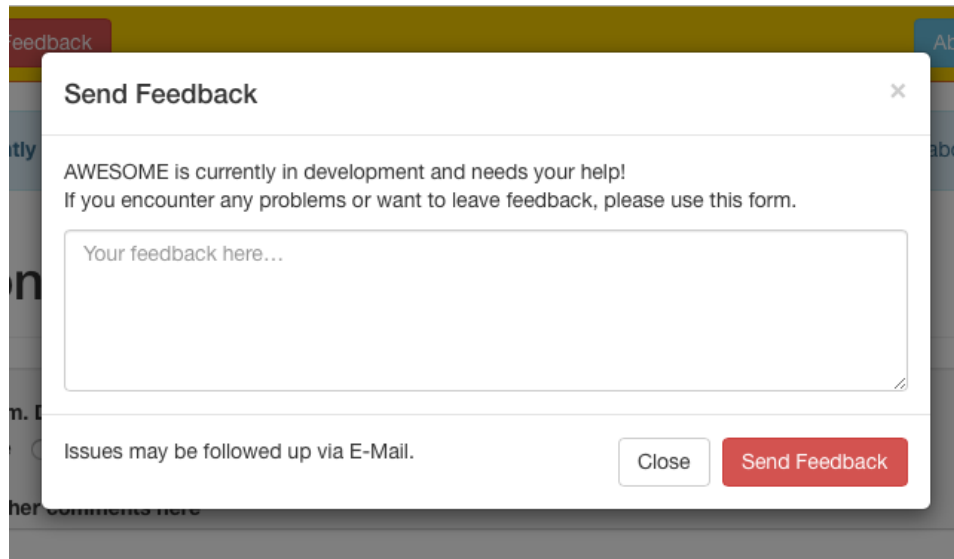


Figure 3.7.: A comparison of respondents between the prototype version and the submitted version of AWESOME

Additional features include a feedback form when AWESOME is in debug mode. This allows users to send an email to developers, containing any text they wish, as well as automatically including user-agent and other metadata to help identify the problem.



The screenshot shows a modal dialog box titled "Send Feedback" with a close button (X) in the top right corner. The dialog contains the following text:

AWESOME is currently in development and needs your help!
If you encounter any problems or want to leave feedback, please use this form.

Below the text is a large text input field with the placeholder text "Your feedback here...".

At the bottom of the dialog, there is a line of text: "Issues may be followed up via E-Mail." followed by two buttons: "Close" and "Send Feedback". The "Send Feedback" button is red, while the "Close" button is white with a grey border.

Figure 3.8.: A screenshot of the feedback form in AWESOME

4. Implementation

4.1. Implementation

5. Testing

5.1. Automated Testing

For this project, a Continuous Integration (CI) platform was chosen to be used in order to facilitate automated unit tests. By using CI ensured that every time code was committed with unit tests, the suite was ran and results were instantly available. Any test failures resulted in a notification email being sent to identify when and where a problem had occurred.

After seeing fellow classmates use TravisCI¹ on previous projects, and reviewing the features it provides, I decided to utilise it in this project. Travis offered testing across multiple PHP versions, which proved helpful when trying to provision a server on the university network.

This was indispensable mid-way through the project, when functionality in the i18n framework needed to be changed and tests started to fail. I wouldn't have noticed any errors when manually testing, but the unit tests brought up edge cases which were then dealt with.

5.2. User Testing

User testing was carried out by creating a survey and entering volunteer's AU usernames in the student CSV data along with sample modules. The first real test through the AU servers was sent to staff. This uncovered many issues with the setup of AWESOME on the AU server, which took some time to fix. After these issues were resolved, an end-of-semester questionnaire was sent out to the vast majority of students in the Computer Science department. From first years, to masters students.

User testing revealed some useful information via the feedback form, as well as through a question in the survey which was asked about how easy AWESOME was to use.

¹TravisCI Homepage: <http://travis-ci.com>

5.3. Acceptance Testing

Acceptance testing was carried out on the submitted version of AWESOME and results in test tables can be found in Appendix A with 16/18 (89%) of tests passing. More detail of the two failing tests can be found in the appendix entry.

6. Evaluation

6.1. Process

6.2. Development Environment

6.3. Project Stages

6.4. Blog

6.5. Degree

6.6. Upper Management

6.7. Time Management

6.8. Future Scope

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A. Test Tables

These tests were carried out as part of acceptance testing using the submitted version of AWESOME. Results are listed below.

- Test D8 fails as there is currently no safeguard in place for incorrect CSV format.
- Test D12 fails as questionnaire respondent tokens aren't created until the moment of sending.

Both of these issues a quick fixes, but are unable to be implemented in time for the dissertation hand-in. They will be fixed in a future version.

ID	Requirement	Input	Expected Output	Actual Output	Pass
Q1	Students receive an email with a link to personalised questionnaire	Check email inbox	See an email with unique link	See an email with unique link	✓
Q2	Questionnaire can be viewed correctly	Click link in email	See questionnaire displayed	See questionnaire displayed	✓
Q3	Answers can be selected or filled in	Click on a Likert rating or type in a text box	See answer selected or text typed in	See answer selected or text typed in	✓
Q4	Answers can be submitted	Select or type some answers and press the send button	Page redirected with a message informing of completion	Page redirected with a message informing of completion	✓
Q5	Questionnaire can't be completed twice	Re-visit the unique link and try to complete the survey again	Receive an error message informing that the questionnaire has already been completed	Receive an error message informing that the questionnaire has already been completed	✓

Table A.2.: Acceptance testing of AWESOME's Questionnaire