

Project Dissertation

School of Computing & Information

An interactive Java Learning resource tool

Jason Wallace

B00528991

Supervisor: Gaye Lightbody

Second Marker: Simon Fraser

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<https://github.com/jasonwallaceuuc/java-learning-environment>

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Abstract

Students have a variety of different learning styles and make progress in understanding new technologies and concepts at a variety of different rates. Students have a vast amount of learning resources available to them provided by the University, which can include lecture notes, lab exercises, tutorials and code handouts. Another source of material is through a student's individual learning and can include video tutorials, online exercises, forum posts and online notes. These self-directed learning resources may be of use to the individual however they are not tailored to the individual's learning needs.

What is envisaged is an interactive syntax learning resource for Java programming, that will assist students in their learning by providing a variety of interactive syntax learning resources that are tailored to adapt to an individual students learning needs. The learning resource will act as a blended learning tool in which the student has control over the pace and what they learn. This syntax learning tool is named the Interactive Java Learning Resource and is designed as a free web application for students learning Java as part of the MSc Professional Software Development course as well as those students learning Java in the various computing courses throughout the Universities campuses.

Design and user requirements were identified by meeting with key project stakeholders. A prototype and framework for the website has been developed, implement and finally tested by a group of students who have completed the MSc course

Keywords: Interactive Learning, Blended learning, Web Application, Java, Tailored Learning Resources.

Introduction

1.1 Introduction

For a student with no previous experience in computing, learning a new programming language can be a daunting experience for some. There is an abundance of learning materials provided to students, whether that be through the University or self-directed resources that they have found during their own individual learning such as video tutorials and online documents. These learning resources can be of great benefit to the student however they are not tailored to the individual students learning needs. For a student learning Java programming it may be hard for them to pinpoint exactly in what area they need help or support with as they are unfamiliar with the subject. They may need help with the syntax of the language or on how classes and methods work and will naturally go online to try and find a learning resource on what they need help with. The problem is that there is such a vast amount of resources available to them that they could become overwhelmed or be even given false and out of date information.

Many of the learning resources, that first appear upon a simple search of a Java problem, direct students to websites like stackoverflow which are made up of contributions from the Java programming community. With these types of learning resources there is no real way to ensure their correctness and integrity. There is also no guarantee that they are the sort of learning resource that the student needs as they normally do not tend to go into too much detail on how a particular answer is achieved. It is vital that the student is able to understand the path to a particular answer instead of just being provided with the solution.

A solution to the problem was to create not only a syntax learning tool for students to learn Java programming but to create the framework for an interactive learning experience in which students can use as a blended learning tool, which runs alongside the Masters course in software development. They can work at their own time and pace and have tailored learning resources that meet their particular needs. The learning resources are controlled by the lecturer, so the student can be confident that the learning resources they are given are not only tailored to their needs but they are relevant and useful to the module that they are working through.

1.2 Problem Statement

Students have a variety of different learning styles and resources available to them and make progress in understanding new concepts at different rates. These self-directed learning resources may be of benefit to the individual student however they are not tailored to their individual learning needs. With a vast amount of learning resources available on the web and many of these resources being from non-academic sources there is no guarantee of their correctness, integrity and relevancy to the Software Development course. What is envisaged is a framework for an interactive Java learning resource in which the student can work through at their own pace, with progress check points and subject testing so that the student, and lecturer, can assess their understanding of Java as they advance through the learning material.

1.3 Aim

The aim of the project is to create an interactive Java learning resource tool for students currently studying Java programming as part of the MSc course in Professional Software Development as well as those students studying the languages as part of the undergraduate computing courses. The learning environment offers a personalized learning environment where students can learn Java at their own pace and as a blended learning tool to the Masters course. The learning environment should adapt to the students learning needs by offering tailored learning resources, selected by the lecturer.

1.4 Objectives

In order to achieve the above aim the following objectives were decided upon at the start of the project:

- Conduct background research on the topic of blended learning and how students would benefit from having such a tool.
- Examine current interactive learning solutions that are currently on the market such as w3schools.com

- Meet with project stakeholder to discuss content, layout and formal requirements for the syntax learning resource, based on in-depth user stories.
- Design and create the syntax learning resource based on functional and non-functional requirements gathered during the planning stage.
- Administrate testing of the website and its core functionality by having a selection of current students use the website.

1.5 Development Requirements

The development of the Java syntax learning resource has required the use and understanding of a selection of programming languages and software. To complete the creation of the learning resource the project owner completed individual learning on web-development tools and software to ensure the project's success. It was decided the learning resource should take the form of a web application. For the web application all database information and website files has been stored locally. What follows is a list of the hardware and software used to create the web application.

- Windows 10 operated desktop and laptop computers.
- Atom text editor with inbuilt syntax and error highlighter for PHP, JavaScript, HTML, CSS
- XAMMP web-server solution pack which gave access to PHPmyAdmin and access to SQL database functions

In order to keep project costs to a bare minimum all of the software and hardware used to create the website have been free open-source software and hardware that was already acquired prior to the start of the project.

1.6 Dissertation Outline

Below is the outline for the remainder of the dissertation. For page numbers and references please consult the project contents on page 2.

Chapter 2, Analysis, presents the background research that has been completed on the problem and provides an overview on the solution that has been presented and other possible avenues that were explored. This chapter also explores the functional and non-functional requirements for the learning resource that were gathered through meetings with the project stakeholder.

Chapter 3, Design, this chapter covers the design of the user interface, software architecture, data definitions, database design schemas, and other high level descriptions of the creation of the learning resource.

Chapter 4, Implementation, this chapter includes the development approach to creating the learning resource and any learnings from the original prototype version that was created in the first and second project checkpoints. This chapter also covers more in-depth descriptions of what software and language have been used to create the learning resource as well as examples of specific algorithms used to create key parts of the learning resource.

Chapter 5, Testing and Evaluation, this chapter explores how the final prototype of the learning resource has been tested and the results of questionnaires that were handed out to candidates who tested the learning resource's functionality. The evaluation part of this chapter assesses the value of the learning resource against the list of requirements mentioned in chapter 2.

Chapter 6, Conclusions, this final chapter summarized the overall project as well as recommendations and changes for the project if it were to be created again.

Analysis

Introduction

This chapter begins with a short background review of blended learning and an analysis of the problems associated with students learning Java programming for the first time. The chapter then presents the benefits that blended learning environments have on an individual's learning. The chapter then presents solutions to the problem by examining existing learning environments available on the web and how they attempt to aid students in their learning of basic programming. The learning resources that were examined cover a wide range of programming languages as there is few dedicated learning environments that solely cover the Java programming language however their design features and interactivity are useful to examine.

2.1 Background Review

With the advancement of computers and the rise of the internet, e-Learning has become a very big part of how institutions train and educate their clients. In 2003 the e-Learning market reached more than \$15 billion in products and services (Bersin, 2004). The rise of e-Learning has meant more and more educational institutions are incorporating blended learning into their teaching syllabus. Blended learning is a term increasingly used to describe the way in which e-Learning is combined with traditional classroom teaching methods and independent study, to create a new form of teaching methodology. In 2000 it was reported that, in the United States, roughly 45,000 K-12 students took an online blended course and by 2009 that number increased to 3 million (Horn, Staker 2011).

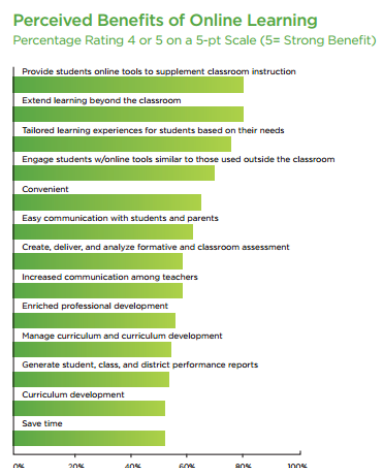
Fully online learning courses have been well established in educational institutions for a number of years however many institutions appear to be struggling with conceptualizing and implementing a blended learning experience. When blended learning environments succeed they have done so when they are strategically aligned with their institutions syllabus and goals (Blended Learning Toolkit, UCF). Therefore, it is best to think of blended learning as an additional element to classroom teaching rather than a substitute.

2.1.2 Benefits of Blended Learning

By incorporating a form of blended learning educational institutions have observed the following benefits:

- **Improved efficiency of teaching-** When students work within a blended learning environment they are receiving online feedback instantly, working with learning resources and material that adapt to their learning needs. This frees up more time for the lecturer or teacher to spend time with struggling learners and those that need help.
- **Personalizes learning-** Blended learning personalizes learning resources and feedback to the student's individual needs allowing them to work at their own pace, ensuring they understand new concepts before moving on.
- **Robust student data-** Software used with blended learning allows for lectures and teachers to have access to data that they never had. Data, such as the average time it took a classroom to learn a particular topic, is available to examine and work on. Individual student performance is easily recorded and can be acted upon.

Graph 1 shows market research commissioned by Blackboard Inc. aimed at higher educational teachers and their views on the benefits of blended learning. The graph shows that educators view the key benefits of blended learning from the vantage point of student learning.



Graph 1

2.1.3 Negatives of Blended Learning

There has been limited rigorous research conducted on the effectiveness of blended learning models, so there is no real way to assess the effect it has on an individual's learning performance (M & S Dell Blended Learning Report 2014). Many blended learning environments today suffer from a lack of interactivity with many blended learning classes offering text-based materials or recorded lectures and podcasts (Donnelly & McAvinia 2012). By incorporating a blended learning environment, it is important that the social interaction a student has with both their lecturer and class mates is not lost. The interaction a student has with their lecturer is a vital part of the course they are taking.

2.2 Problems faced by students

Without any sort of blending learning environment students, learning Java programming, face a number of problems when it comes to how efficiently they learn the material required. Some of these problems are brought about by the type of learning resources the individual student is learning from. The learning resources that they are using could be out of date or inaccurate or it could be a completely different approach to a certain solution that the lecturer is looking for. Some of these problems are also brought about by the students individual learning habits and their behavior towards learning. These problems are listed in table 1 below.

2.3 Problems faced by lecturers

Not only do students face a variety of problems when learning Java for the first time but the lecturer in charge of teaching students also faces a variety of problems when trying to teach the material required. Lecturers teach a vast number of students who have different needs and learn in a variety of different ways. Many students learn at different paces and engage with the learning material in different ways. This can affect the type of learning resources that lecturers give to their students as they will never suit everyone in the class. The problems faced by a lecturer are

presented in more detail in table 1. Appendix 1 graphically highlights the problems faced by students and lecturers through a rich picture diagram.

<u>Problems faced by Students</u>	<u>Problems faced by Lecturers</u>
Students may not understand what is being taught during the lectures	Individual students have a variety of different learning styles. Hard to choose specific learning resources that will accommodate these learning styles
Students have limited access to readily available and immediate feedback	Hard to give immediate and readily available feedback to the entire class without class tests or exams.
Student attendance is crucial in a such an intensive course such as the MSc course in Software Development. One or two days' absence means a lot of teaching is missed	Lecturers have a very limited window to talk to students and ensure that they fully understand what is being taught to them. Limited time after lecturers and during labs
Students may not fully understand what is being taught to them and only have a limited time frame to ask lecturers questions face to face	Dealing with such a large number of people learning a topic for the first time, it can be difficult to assess students learning and understanding over the duration of the course
Students may think they know a certain topic of Java when in fact they have got it completely wrong. They may not pick up on this until later on in their learning	Lecturers have a strict timetable that they need to adhere to, to ensure that all of the learning is completed in time for the end of the modules and course
The vast amount of learning resources on the internet and given to them by lecturer can be overwhelming	There is no dedicated system for lecturers to assess student learning and progress as the module progresses without them taking time to discuss with each individual student
Students may be learning from out of date or inaccurate learning resources through their individual learning	

2.4 Solutions to help students and lecturers

The solution to the problems faced by both student and lecturers is to create an interactive blended learning environment to assist students learning Java programming. By making use of interactive and tailored learning resources, together with progress checkpoints, subject and knowledge testing the solution aims to assist students learning Java by offering the features mentioned as well as a personalized learning environment that provides immediate and useful feedback.

2.4.1 Target Audience and Stakeholders

The target audience for the interactive Java learning resource as well as key stakeholders are shown graphically in appendix 1. The main target audience for the solution are those students who are currently learning Java programming as part of the MSc Professional Software Development course, and to a lesser extent, students learning Java as part of their first year in Computer Science at undergraduate level. The key stakeholder in the project is the project supervisor, who as a teacher at the University of Ulster would be able to make use of the interactive Java learning resource to assist their students.

2.4.2 Proposed solutions

It was decided, while meeting with the key stakeholder, that the learning environment should take the form of an interactive web application. The idea of creating a mobile phone application for Android devices was explored however it was decided that a web application would be the more favorable option however it is important that the web application is responsive to screen size as many people view web pages on their mobile phones. It was then decided that a web application would be the more ideal solution to the problem. These pros and cons are listed in tables in appendix 2.

2.4.3 Technical Benefits to Students

The creation of a web application would result in the following technical benefits for both the student and the lecturers involved;

- Help students to learn the basic principles of Java programming
- Increased student performance and confidence
- Students have access to immediate feedback
- Subject and topic testing allows students to assess their ability immediately
- Lecturers can assess students ongoing performance
- Students can learn Java at their own pace in line with the Software course
- The web application is expandable by offering a framework that can be built upon
 - Once lecturer is taught how framework is designed it can be changed to incorporate more advanced aspects of Java programming.
 - Can be built upon to incorporate other modules involved in the course
 - Lecturer can add additional content and change the learning resources

2.5 Current Interactive Learning Sites

In order to develop a suitable solution to the problem, it is important to examine and analyze solutions that are currently available. Although these web applications are stand-alone learning resources and not blended learning environments they are useful to assess when examining how applications teach people over the web. In total four websites were selected for review.

- W3Schools – www.w3schools.com
- Code Academy – www.codecademy.com
- Khan Academy – www.khanacademy.org
- Code School- www.codeschool.com

These websites have been chosen as they were the first websites that appeared after a simple google search of programming learning websites. For each site a pro and con list has been created to assess its features, accessibility and key functions.

2.5.1 W3Schools

The screenshot shows the W3Schools website interface. The top navigation bar includes links for various technologies. The left sidebar lists JavaScript topics. The main content area is titled 'JavaScript Statements' and includes an 'Example' section with a code snippet: `document.getElementById('demo').innerHTML = 'Hello Dolly!';`. To the right of the main content is a blue sidebar with promotional text: 'Standard, simple and user-friendly', 'The best service is selfservice', and 'For every company the best solution'. At the bottom of the blue sidebar is a green button that says 'Try our software!'.

Table 2

	Pros	Cons
Learning Content	Vast number of topics broken down into smaller and easy to manage learning topics.	Only covers web building programming technologies and does not cover Java.
Features	Code simulations, examples and a topic quiz and end of module. Easy to navigate between each topic	No test or quiz under each topic only a test towards the end of each topic. Learner has no way to constantly monitor their understanding. No video tutorials
Accessibility	Good use of headings to separate each learning topic as well as good use of color for code to highlight important pieces of code. Good use of font sizes.	Could make use of more color to highlight important pieces of text rather than just important pieces of code. Not much interactivity other than code simulations
Usability	Consistent layout and presentation of learning sections	No real help function or guide to using the web application
Compatibility	Fully responsive based on screen size	Limited screen size means learner constantly having to scroll screen to read all of the information
Other	Discussion forum Useful references such as CSS color picker	Does not offer personalized feedback and learning. Also does not have a function to create a user account and save progress. Use of advertisements takes up vital screen usage

2.5.2 Code Academy

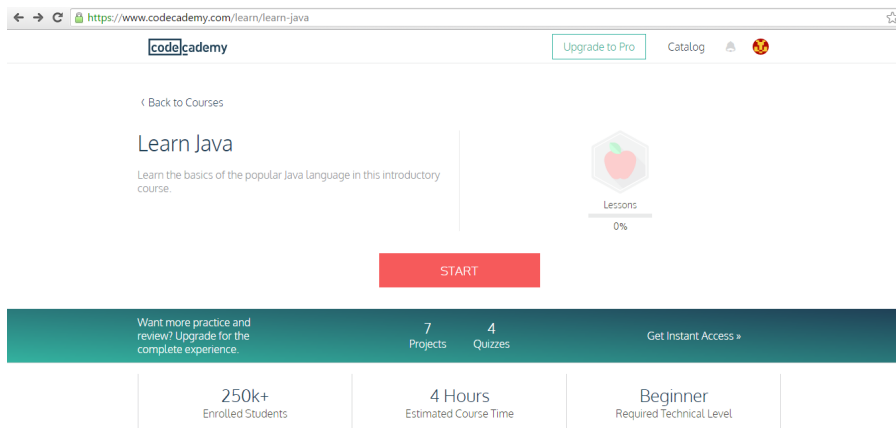


Table 3

	Pros	Cons
Learning Content	Topics ranging from Java to web building languages as well as a guide to Github.	
Features	High level of interactivity that makes use of progress check points, code simulations, tests and learning material. Offers a personalized learning environment by use of user accounts	Main focus of the site is on code simulations, there is not a lot of descriptive information about how Java works No video tutorials or any other learning resources
Accessibility	Good use of font sizes and background colors to distinguish between different sections of each web page	Once learner has started a new topic there is no navigation menu to move between different topics. Have to constantly use the next and previous button to move through topics
Usability	Consistent layout and presentation of learning sections	
Compatibility	Pages load in adequate time for the amount of interactivity it offers	When working through a topic the site is non-responsive to screen size making it harder to work through on other devices.
Other	No advertisements	Allows user to pay to upgrade their learning experience by going 'pro'. May alienate certain users who do not wish to pay

2.5.3 Khan Academy

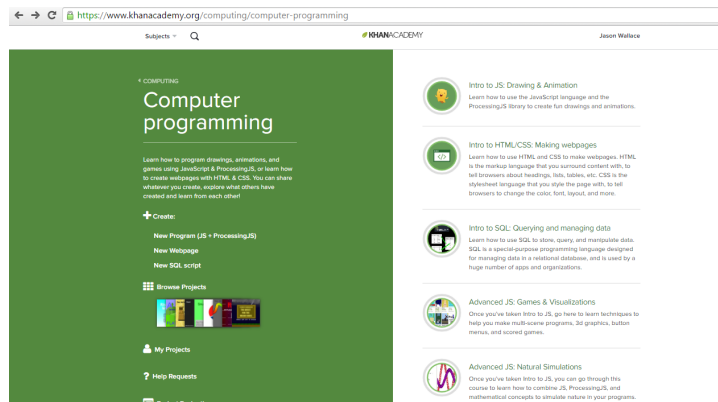


Table 4

	Pros	Cons
Learning Content	Wide range of topics ranging from computer programming and computer science as well as math, algebra and other unrelated topics.	No dedicated section for Java programming
Features	User registration allows for personalized learning environment with progress check points. Allows user to create a project in which other users can rate and evaluate	No real way for a learner to assess their understanding of a particular subject as learner testing is limited. Although there is a high level of interactivity it does little to help the learner.
Accessibility	Good use of font sizes and background colors to distinguish between different sections of each web page	Hard to use navigation made the site confusing at times
Usability	Consistent layout and presentation of learning sections	
Compatibility	Pages load in adequate time and there are no real bugs or issues with the features of the site	Aspects of the site are responsive to screen size such as the navigation menu however most parts of the site are unresponsive
Other	No advertisements	

2.5.4 Code School

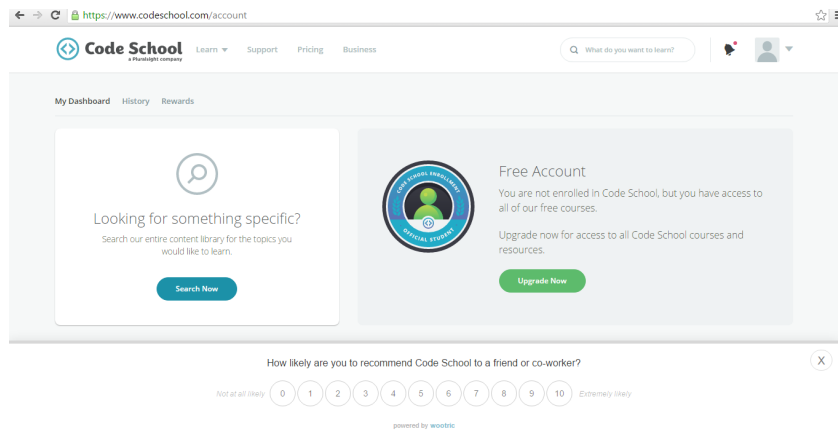


Table 5

	Pros	Cons
Learning Content	Wide range of programming topics to learn	No dedicated section for Java programming
Features	User registration allows for personalized learning environment with progress check points.	Most of the learning material on the website is only available to subscriptions users at a monthly rate of \$28 a month.
Accessibility	Good use of search function to search for topics. Good use of dashboard to show progress and recent topics.	No way to navigate to a certain topic without searching for it.
Usability	Consistent layout and presentation of learning sections.	
Compatibility	Pages load in adequate time and there are no real bugs or issues with the features of the site. Website is responsive to screen size.	
Other	No advertisements.	The focus of this site seems to be on making money rather than offering a good learning experience. Constantly asked to take surveys on how you would rate the site.

2.5.5 Key Findings

All four of the web applications evaluated offer an interactive learning experience to their users allowing users to work through each site at their own pace. For the purpose of the project two of the websites evaluated are of more use when designing the interactive Java learning resource. W3schools has a very easy to use navigation system which allows users to move between topics and different programming languages at ease. It also makes very good use of programming simulations that allows the user to receive immediate feedback. The main drawback for W3schools is that the site does not offer a personalized learning environment as it does not have the ability to create user accounts. By offering the facility for a user to register it allows for them to have their learning progress saved and also have any test scores saved to their profile, which is useful when assessing an individual's learning and grasp of a particular subject. Although W3schools does not have a dedicated section to learn Java programming it was very well laid out and inspiration can be drawn from its navigation system and usability.

Code Academy makes use of user registration and allows a user to easily navigate to the subject that they were previously working on which is extremely useful. Code Academy does have a big focus on code simulations and practicing different programming exercised however it does little to explain how Java code actually works. This means that a user may be able to repeat various coding exercises however they may not actually understand how the code actually works.

Khan Academy and Code School do have a high level of interactivity however their navigation systems are hard to navigate with ease and they have very little learning resources for Java Programming. Code School's free account has little access to its vast amount of learning resources compared to that of Code Academy which still gives users access to a vast amount of learning material.

2.5.6 Recommendations

From evaluating already available solutions the following points should be taken into account when designing the Java learning environment:

- The Java learning content should include a mixture of both interactive learning as well as descriptive text and learning resources such as video tutorials.
- The web application should offer free access to all of its facilities and learning material. It would be bad practice to ask students to pay for a service provided by the University outside of their course.
- The website should offer user registration and provide a personalized learning environment for each user.
- Lecturer must be able to change and adapt the learning material on the website so that it can fit in with the modules learning program.
- Accessibility and usability should be the most important aspect when designing the website. The website must be responsive to screen size and offer an easy to use navigation system so that students do not waste time trying to change a topic to learn.
- The learning material on the web application should be in line with the current MSc Professional Software Development module and focus on Java programming.

2.6 Requirement Analysis

This section of chapter two reports on the functional and non-functional system requirements of the project which were gathered during meetings with the key project stakeholder who had valuable input as a University lecturer. User stories have been created to draw up a list of requirements for both main users of the Java syntax learning resource, the lecturer and student users.

2.6.1 Pre-Requirements

As discussed in section 2.4.2, a web application is the most appropriate application as a solution to the problem mentioned. As a result, there are a list of pre-requirements that can already be set. The web application must be cross-browser, meaning that the web application will work

across any browser. The web application must be free of charge and not have any sort of premium subscription service for the reasons mentioned in the competitive analysis section.

2.6.2 Requirements for Disabled People

Around 20 percent of people in the United Kingdom have difficulty accessing internet resources due to their disability (About Web Accessibility for Disable People, 2010). In order for the learning resource to meet the needs of those students with disabilities the web application must also adhere to development guidelines stated in the Web Content Accessibility Guidelines (WCAG) issued by the W3C Web Accessibility Initiative. The WCAG documents how to make web content more accessible to people with disabilities. By following the guidelines, the web applications content is accessible to people with a wide range of disabilities such as blindness and low vision and photosensitivity (Web Content Accessibility Guidelines WCAG 2.0 Dec 2008), which would be the most common disabilities amongst users of the learning resource.

2.6.3 User Stories

In order to come up with a list of functional and non-functional requirements for the web application a list of user stories has been created from both the student's needs of the web application as well as the lecturer. As the key stakeholder, the lecturer will have different needs for the web application than the student. The lecturer will need to have administrative control of the web application so that they can control the learning and testing material for the students. The lecturer will also need to have access to relevant data on how the students are performing using the web application, this will include having access to test scores and any files the students have uploaded for review. These requirements are given in more detail in the relevant section.

2.6.4 Student User Stories

Table 6 shows the user stories from the perspective of the student.

Number			
1	As a student I	Want to control the pace in which I learn	So I can learn at my own rate
2	As a student I	Want to have immediately available feedback	So I can assess my learning instantly
3	As a student I	Want to be able to login to my own personal profile	So my details and information are stored on the system
4	As a student I	Want to be tested on my learning of Java	So I can assess my learning of the topic
5	As a student I	Want to have my test scores saved	So I can view my performance
6	As a student I	Want to navigate easily within the web application	So I can learn each Java topic with ease
7	As a student I	Want free access to the web application	So I do not have to pay extra for learning resources
8	As a student I	Want to have a wide range of interactive learning resources	So that I am not constantly reading from text material
9	As a student I	Want the ability to upload work	So I can send any work to the lecturer to review

2.6.5 Lecturer User Stories

Table 7 shows the user stories from the perspective of the lecturer.

Number			
1	As a lecturer I	Want to have access to the inner workings of the web application	So I can control the content of the web application
2	As a lecturer I	Want to have an administration account	So I can view student records
3	As a lecturer I	Want to have the ability to view student test scores	So that I can assess their performance
4	As a lecturer I	Want to be able to view any files uploaded to the web application	So that I can review students work before class

2.6.6 Shared User Stories

Table 8 shows the list of shared needs that both the student and lecturer have from the web application.

Number			
1	As a user I	Want the web application to run smoothly and efficiently	So that I am not delayed waiting on the web application loading
2	As a user I	Want the website to be able to login correctly	So that I do not have any issues when trying to login to the web application
3	As a user I	Want the web application to be secure	So that my personal data is not at risk of loss or data piracy
4	As a user I	Want the web application to have the ability to run on any web browser	So that I can use it on any available browser
5	As a user I	Want the web application to be responsive to screen size	So I can make use of the web application when on a small screen
6	As a user I	Want the web application to have an acceptable response time	So I can work through the content of the web application efficiently

Requirements

3.1 Requirements

Based on both the competitive analysis and the user stories created by meeting with project stakeholders, a list of functional and non-functional requirements were decided upon. These requirements are listed in bullet point form below.

3.2 Functional Requirements

Functional requirements describe the websites functionality. The following requirements were created for the design of the web application:

- Students and lecturers must have the ability to login to the web application.
 - Registration to the web application will be done by registering a username and password as well as their student or lecturer University number and a contact email address. All information will be stored securely onto the project database.
- The web application should offer a mixture of interactive and text based learning resources that students will work through.
 - The lecturer can control the content of the learning resources to ensure students are learning from up to date information
- The web application should have the facility for students to be tested on their learning of a particular Java topic so they can assess their understanding.
 - Web application will be stored student test scores to a database.
 - Students will be unable to proceed to the next section if they do not obtain a satisfactory test score.
- The web application will have a fixed navigation path that the student will work through with a pass mark of 50 percent for students to be able to move onto the next section of the web application.
 - This will ensure their understanding of a topic before moving onto more advanced work

- The web application should have the facility for students to upload any work that they have completed. The work is then viewable only by the student who uploaded the work and the lecturer.
- The web application should have an admin facility for the lecturer so that they can control the overall content of the web application.
 - The lecturer should be able to create and amend tests that the student takes so that the questions are different.
- The web application should offer immediate and tailored feedback based on the students test performance
 - Should be a variety of learning resources that are offered as feedback such as video tutorials and simulations.

3.3 Non-functional Requirements

Non-functional requirements place certain constraints on how the web application will list its key functional requirements listed above. They describe the performance and layout of the web application. The following non-functional requirements were drafted into the web applications design:

- Web application should have a high level of efficiency and compatibility.
 - Will have a response time rate of no longer than 1.25 seconds.
 - Web application should be compatible with a variety of web browsers and hardware.
 - Must be responsive to variety of different screen sizes.
- All students should be able to interact with the website and its core functions with ease. This includes any students with disabilities mentioned in section 2.6.2 of this report.
 - To achieve this level of accessibility adequate font size and text has been used.
 - No white background to help with dyslexic users.
- The design of the web applications layout should be aimed at University level students.
 - By incorporating a professional yet fun design interface

- The web application should have a strong sense of reliability with a clear statement on who to contact should there be any problems with the web application.
- The web application should be created using best practice coding standards in the case that the web application is extended upon in the future.
- The web application should be easily recovered in the case of a database failure or crash.

3.4 Summary

This chapter has examined the problems faced by students when attempting to learn Java programming for the first time as well as the problems faced by University lecturers trying to manage students learning the programming language. The chapter then went on to present a solution to the problem in the form of a blended learning environment for students to learn Java programming at their own pace and to work as a learning aid to the Masters course at the University of Ulster. Chapter two then went onto discuss background research into the topic of blended learning. Finally, the functional and non-functional requirements were listed, having been drafted from user stories and meetings with the key project stakeholder.

Design

Introduction

This chapter will present the design and creation of the web application's user interface, software architecture and other high level descriptions. This chapter also includes any prototype work and any iterations of the web application that were created. In total, the web application had three different iterations which were created in line with the three project deadline dates. This chapter will explain how each of the iterations of the web application were built and improved upon as well as the reasoning behind the design process.

4.1 Design Methodology

The design of the web application has followed previously established guideless which have been drafted and completed by The World Wide Consortium also known as W3C. This has been done to ensure that the web application has both a high level of accessibility and usability.

W3C is the main international standards organization for the World Wide Web, it is a community made up of organizations and the public to establish and develop website and web application design and architectural standards. The design of the web application will attempt to follow the principals set out by the W3C as strictly as possible, to ensure that the web application is designed with a high level of accessibility as well as usability.

As described previously in section 2.6.2, the design of the web application has followed guidelines set out by W3C to ensure that users with disabilities are able to make use of the Java syntax learning resource. Some of the key guidelines that were followed are listed below and are taken from General Techniques for WCAG 2.0, 2016:

- WCAG Section G1- Ensure there is a clearly displayed link at the top of each page that goes directly to the main content page.
- WCAG Section G71 – Providing a help link on every Web Page
- WCAG Section G184- Providing text instructions at the beginning of a form or set of fields that describes the necessary input.

These are just some of the main guidelines which were followed. For a more in depth analysis of W3C's guidelines on website and web application design please refer to their documentation that has been published.

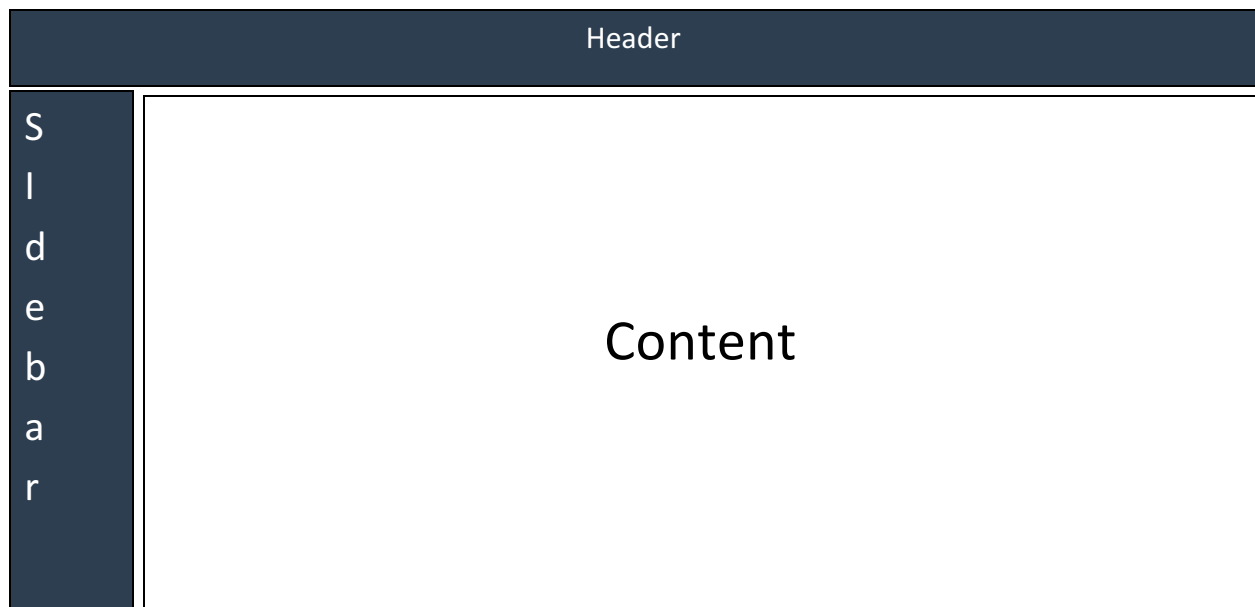
In order to make sure that the web application is also available to those users who suffer from colorblindness a free online piece of software called Vischeck was used to ensure that the color scheme of the web application allows for users who suffer from colorblindness to be able to use the site with ease.

4.3 User Interface Design- Color Scheme

As mentioned above, it is important to have a color scheme that is suitable for those students who have some sort of visual impairment. It is also important to have a visually appealing user interface, having the correct color scheme is vital.

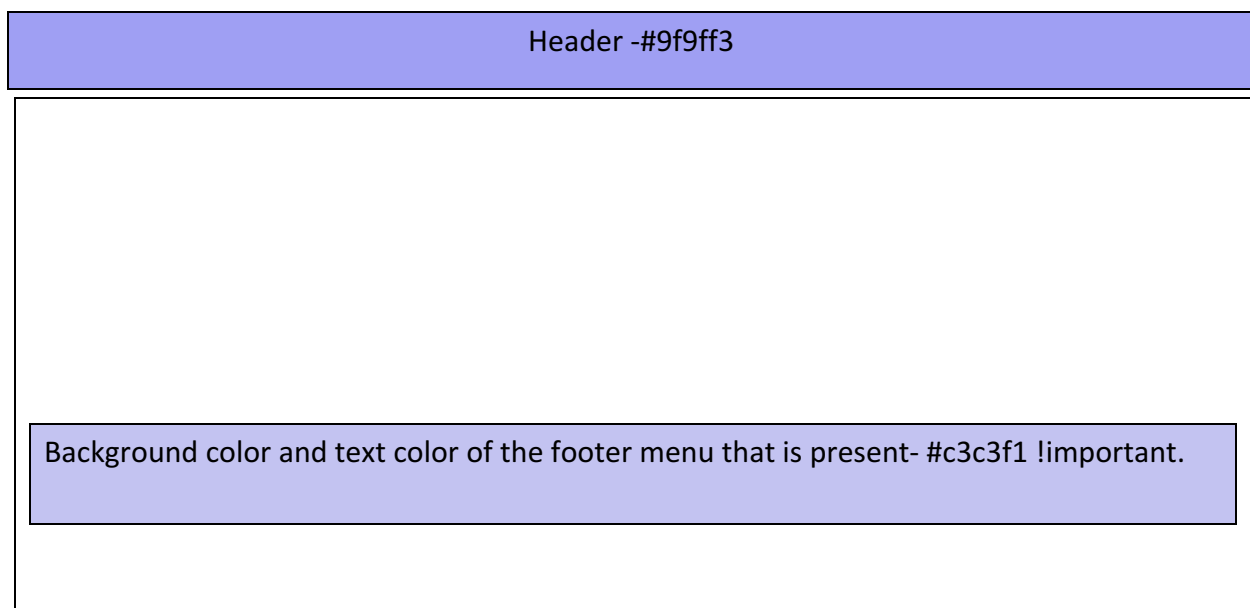
As the web application became more advanced, with each iteration of the Java learning resource, the color scheme became more diverse as there are more design features that need their own color. Figure 1 displays the color scheme that has been used for each iteration of the web application.

Figure 1



The color scheme, in the first iteration of the web application, had a very basic theme with a dark blue background for the navigation header as well as the sidebar. There was no background color present for the main content of the web page. As this was the first iteration of the web application the color scheme was not an area that was particularly focused on. As the design of the web application improved and with more features being added the color scheme became more of a focus. This was to ensure that the readability of the web application tied in with the design methodology influenced by the guidelines of W3C.

Figure 2 represents the color scheme that was used in the second and third iteration of the web application. The color scheme changed considerably for multiple reasons. The first was to change the white color of font in the headers and within any navigation menus that were present, as using a white colored font is harder for people to see. Another important change was to use lighter colors with darker fonts. This was done so that it is easier for users to read the text on the screen. The overall color scheme of the web application was changed to a lighter tone as users of websites tend to prefer a lighter tone over a darker one. In a recent survey carried out by Darren Rowse, founder and editor of Digital Photography School, showed that 47% of users of digital blogs and websites preferred a lighter tone with darker text compared to 10% of users who preferred a darker tone with lighter text (Rowse, 2009).



A detailed breakdown of the colors used with their relevant hex color code can be seen in table 3.

Table 3

Feature	Color used
Login Background	#c3c3f1
Login Button	Default bootstrap modal green
Login Help Icon	Default image color orange
Main Header	#9f9ff3
Main Bootstrap Jumbotron	#c3c3f1
Main Admin Panel Background	#c3c3f1 !important
Main Navigation Dropdown Menu	#668cff
Main Bootstrap Modal Button	Default bootstrap modal green
Main Glyphicon Icons	#c3c3f1
Main Video-player Button	Default image color
Main Practice & Module Test Buttons	Default bootstrap modal green

Table 3 presents the color pallet used for the second and final iterations of the web application. Different shades of light blue have been used for background colors and large areas of space that include links and important information for the user. Orange has been used for interactive images to stand out to the user. Green has been used for the various buttons throughout the web application. These colors not only adhere to W3C's design guidelines but they have been chosen and implemented because they are visibly appealing to look at, making the web application more fun and enjoyable to use. Not only must the web application have a user interface that can be easily use by anyone but it must also be visually appealing to the user and have a high level of human computer interaction (HCI). This is important as by having a good design framework for

the user interface in a learning environment such as this, it will help improve the overall learning experience for the users (Nam & Jackson 2007).

4.4 Font Styles

An easy to read font type is important with previous research indication that the way in which large parts of texts, in web applications, is presented may have a significant impact on usability and readability (Ling, J, May 2006). With the web application having large parts of informative text, an easy to read font type has been chosen. The Sans Serif font style has been chosen for the web application as it is easy to use and popular amongst many modern web applications. Another option that was considered was the Comic Sans font however it was decided that Sans Serif was more appropriate as Comic Sans has more of a childish theme to it. To make the user interface of the web application more mature and professional, Sans Serif was chosen as the default font type.

4.5 First Iteration

As mentioned, the web application had three different iterations throughout the development lifecycle of the project. The first iteration of the web application and its design features are presented in figure 3. At this stage of the development of the web application, only the home page had been designed, with very little core functionally features being implement at this time. Due to the learning curve associated with learning web development tools, the focus of the development at this stage was creating a framework that could be built upon in future iterations of the web application. This included creating a stable and functioning user interface.

Figure 3

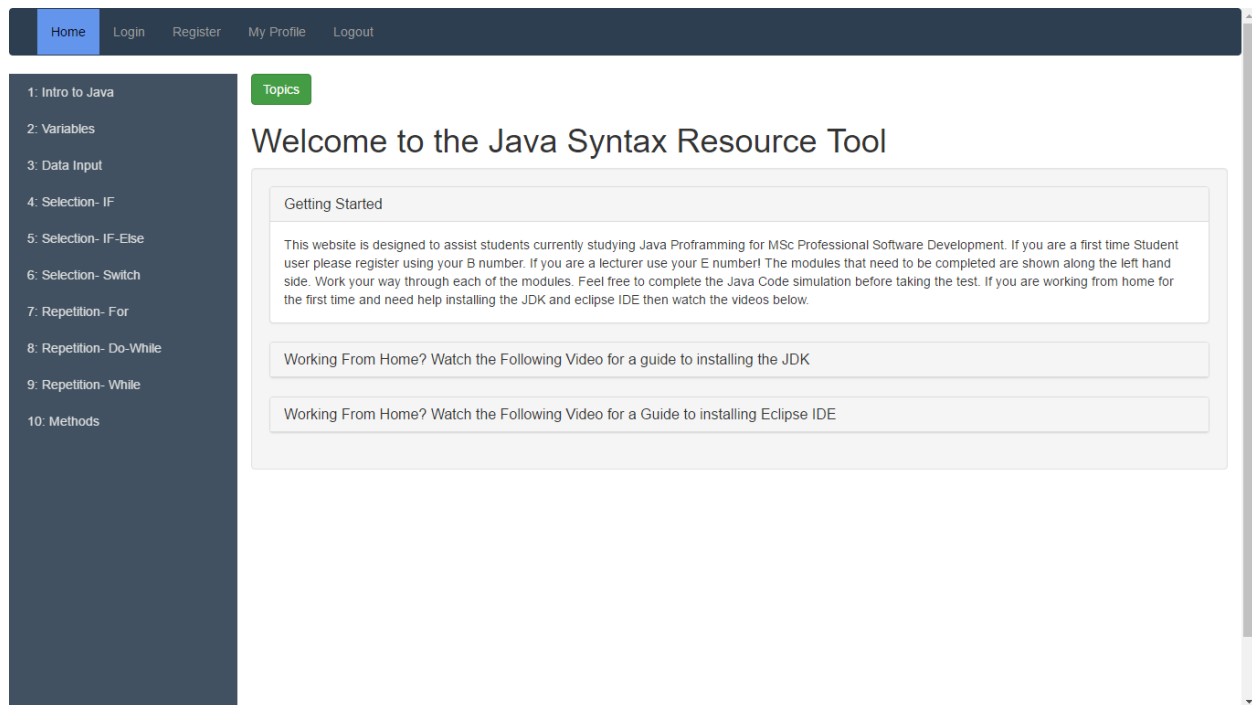


Figure 3 presents the home page of the first iteration of the web application. Some of its key features included:

- Navigation bar along the top of the web application with links to direct the user to key administrative links such as My Profile, Login and Logout.
 - Most of these links became irrelevant in future iterations of the web application as they were not necessary because a student needs to be registered before using the web application.
- Side bar that has links to each of the topics covered by the Java Syntax Learning Resource. These topics were initially chosen as they fit in with the Masters module syllabus. The Side bar can be toggled on and off which gives the student more space to read from, in the main content of the web page.
 - The original idea was that each of the links within the side bar would correlate with the modules of the Masters course. Each of these topics would have their own learning to work through, with a test at the end of each topic.

- The main content of the web page content expandable wells which were intended to be used on every webpage of the web application. This was done in an attempt to make the web application more interactive for the student. This turned out to be counterproductive as mentioned in the next section.
 - The original idea was to have all of the learning resources included within the Bootstrap wells, so that when a student had finished learning a particular resource, they could make the well smaller and move onto the next learning topic.
- Within each of the topics there were interactive features such as text fields in which students could try practicing code simulations. There was no use of any interactive media for learning resources such as videos.

4.5.1 Recommendations for Change

Once the first iteration of the web application was complete, four current students of the Masters course were asked to complete a short survey on their thoughts on the web application. This was done to generate valuable feedback on the design of the web application as the only source of critic for the web application had been the project stakeholder, up until this point. The template of the survey handed out can be seen in appendix 3. Only a very short survey was needed as most of the key features of the web application had been decided upon by meeting with the key project stakeholder.

The results of the survey handed out are presented in table 4.

Number	User Interface /10	Interactivity /10	Comments
1	5	2	Ok layout, no login function, hardly any interactive features would be good to have some video
2	6	5	N/a
3	4	4	Not much to do, bland color, easy to move throughout the website. Too much clicking
4	7	6	Easy to navigate but boring color scheme

User Interface design – Average 5.5/10 Interactivity – Average 4.25/10

As shown in the results of the short survey, the web application's first iteration user interface design had an average score of 5.5 with the interactivity features being below average at 4.25. The interactivity score was expected at this point in the project as this was not the focus of the first iteration. The user interface design score was worrying as a focus of the first iteration was to create a sound and appealing user interface. The comments by students highlight the bland color scheme. As stated, the color scheme was not the focus at this point in the development lifecycle however this feedback provided valuable in the development of the second iteration. The key features of change needed for the second and third iterations of the project were drafted from the survey results as well as meeting with the key stakeholder once the web application had been demonstrated to them for the first time.

- More focus on the web applications core functionality with a focus on the interactive features of the web application.
 - Focus on the web applications learning material and its use as a blended learning environment.
- Change the color scheme to make the site more appealing to the student users.
 - Adding more color and changing the overall tone of the color scheme.
 - Changed to adhere to W3C guidelines.
- Good comments on the web applications easy to use navigation.
 - Inspiration for the navigation menu presented in the second and third iterations came from the first iteration.
 - The navigation bar is a good feature to have as it fits in with W3C WCAG point G1 of having easy to access navigation links on every web page.

4.6 Second and Final Iterations

The second and final Iterations were very similar in their design and functionality because the majority of the work required for the web application was finished by the second iteration. The only differences between the second and final iterations of the web application were some

functionality features such as a practice test feature, which the student can practice questions on the learning material before taking the module test as well, as some minor user interface features. For the purpose of this report, only the final iteration of the project will be commented on. The final iteration of the user interface was designed to be simple, yet efficient and to achieve this the eight golden rules of interface design set out by Ben Schneiderman were followed (Wong, 2016). These rules were followed as they have allowed for the creation of a user interface that is appealing to look at, as a high level of human computer interaction and runs smoothly without any issues.

Figure 4 shows the login screen for the web application, an important feature that needs to have a good user interface design as it is the first interaction any user will have of the web application. The login screen acts as a redirect screen in that if any webpage within the web application is accessed, without the user first being logged in, the user will be redirected back to the login screen. For a more detailed breakdown of the navigation paths a sitemap is presented in section 4.7.

Figure 4 shows the login screen



The login screen has a very basic and minimalistic user interface. It is important that the login screen is appealing to the user, as well as functioning correctly, as it offers users a personalized

environment that they can log in to (Wroblewski August 2011). Some of the key features of the login screen include:

- Easy to read headings and font styles to work in line with W3C guidelines.
 - No large sections of white background to make it easier for Dyslexic users.
 - Changed to a lighter shade of blue with a darker font color.
 - Created using the colors mentioned in table 3.
- Interactive help icon for the student with relevant contact information in the event they have any issues.
 - This makes the web application have a high level of reliability. The owner of the web application, along with contact email, is clearly stated.
 - Hover function allows for the user to only access this feature if needed so it is not cluttering the web page.
 - Image of question mark taken from the internet and recolored to fit in with the color scheme
- Login button opens up a Bootstrap modal dialog box so that the user can login.
 - Bootstrap dialog modal used instead of a popup for a form as many browsers will automatically block a popup box whereas a dialog box will open. The login form can be seen in figure 5.

Figure 5 Login Dialog box

- Popup will appear in the login dialog box to ensure that the student has entered in a valid username and password.

- Including contact email address for web application owner again in the event the student missed the hover for help icon in the previous webpage.
- The login system is designed in such a way that the user cannot access the web applications content without first registering or entering a valid email address and password.
 - This has been done as the only users of the web application should be able to access its core features.
 - Done to keep the web application secure and to meet key system requirements.

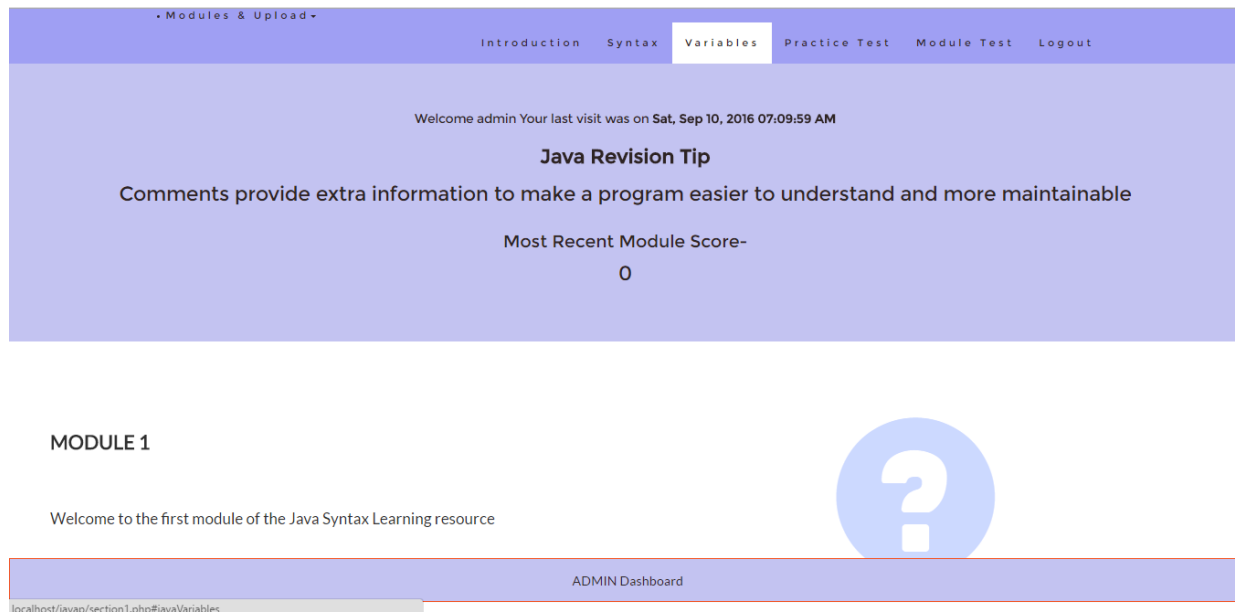
Once the user has logged in successfully they are redirected to the main section of the web application. Figure 6 shows the redirect page.

Figure 6 Redirect Page



- The redirect page has an up to date logo of the University and a redirect countdown.
 - The logo creates more reliability for the web application as it is in line with the Masters course by the University

Figure 7 shows the main page of the web application.



This is the main web page that students and the lecturer will come to once they have logged into the system successfully.

- Instead of the web application having a side bar with many links to different learning topics in the first iteration, there is now a single page layout that contains three different learning topics.
 - Content is presented in a simple, easy and workable fashion for the student.
 - One of the comments from the short survey indicated that too much clicking was involved meaning that there were too many options for navigation in the first iteration.
 - Single page websites have a higher engagement rate from users (Schneider 2014).
- Navigation header allows for student to quickly jump to whatever topic that they want to learn.
 - Heading change color to highlight to the user what section they are currently working on. This is important in a single page web application as there is a vast amount of content in the one page.

- Each of the right hand links of the navigation bar bring the user to learning sections contained within the main web page without having to refresh the screen. This has helped meet key system requirements by speeding up the loading time of the web application.
- Easy for students to return to the start of the web page fitting in with W3C guidelines for disabled users.
- Easy for the student to log out of the system as well as moving onto different sections of the web application.
- Bootstrap Jumbotron box below the navigation bar allows for important information to be displayed.
 - Most recent module score allows the student to quickly assess how well they are performing meeting one of the key functional requirements.
 - Clearly displays who is logged in and the last time they visited the web application, this has been implemented using JavaScript and browser cookie features.
- At the bottom of the main webpage there is a button implemented by JavaScript that brings the user back to the top of the page.
 - Make is easier for users to get back to where they started without having to refresh the page or click on a link.

Figure 8 shows the syntax learning topic of the web page

FIRST JAVA PROGRAM:

Let us look at a simple code that would print the words *Hello World* and the syntax that is involved

```
public class MyFirstJavaProgram { //Notice the uppercase letters for the class name and the opening {

    /* This is my first java program that will print out 'Hello World'
     * Anything written inside the slashes are known as comments. Programs should be well commented
     * Having well commented code allows for others to understand what exactly is going on
     */

    //comments can also be written like this
    public static void main(String []args) { //This is the main method where the program starts. The programs code is written after the opening {

        System.out.println("Hello World"); // Prints Hello World to the console. Notice the semi-colon used at the end of the line of code

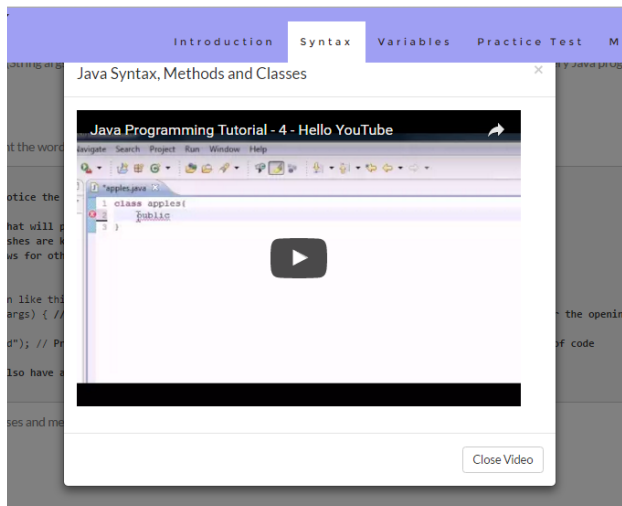
    } //Each opening brace must also have a closing brace. This is the closing brace for the main method
}
```

Click to learn more about Java syntax, classes and methods with TheNewBoston video tutorial



- Interactive buttons that open a video dialog box that contains an embedded YouTube video which can be seen in figure 9.
 - This has been done to add more interactivity to the web applications working on the feedback of the short survey and helping to achieve key system requirements.
- Pretty print section allows for sections of code to be inserted into the web page with relevant code formatting.
 - Allows for code to be presented to the student as it would in a programming IDE.
- Both these features make the web application more interactive for the student.

Figure 9 showing video dialog interactive features



The other learning topics of this section of the web application had similar features to those presented in figure 8 and 9. Icons and buttons have been used throughout the main section to create a high level of interactivity for the student. Similar to the video icon, other icons were used to open other learning resources such as text documents and online tutorials from other web applications.

Appendix 4 shows the user interfaces for some additional features that were added to the web application such as the practice test, module test and the facility for the student to upload a file to the lecturer as well as the admin features that have been added for the lecturer.

Chapter 5 shows key sections of code that have been used in the creation of the user interface and its core functionality. Some of the code includes:

- Code from the login, register and redirect features of the web application.
- Important code from the user interface features.
- Code for the practice test and module test.
- Code for the connection to MYSQL database.

4.7 Sitemap

A simple and easy to use navigation system allows for students to work through any topic that they desire and can quickly switch to another topic or start the practice or module tests. Figure 10 presents the sitemap and the navigation through the web application.

The primary navigation is centered on the login and registration page, if any attempt to any other webpage is made without being logged in then the user will be redirect to the login page. Once a student has logged in they are taken to Module one where they can begin work. If the admin has logged in, with the relevant admin details, then access is granted to admin features that includes viewing and managing student files that have been uploaded as well as a test administrative section. This section allows the lecturer to create questions for the module test and also delete the entire module question and answer database.

Figure 10

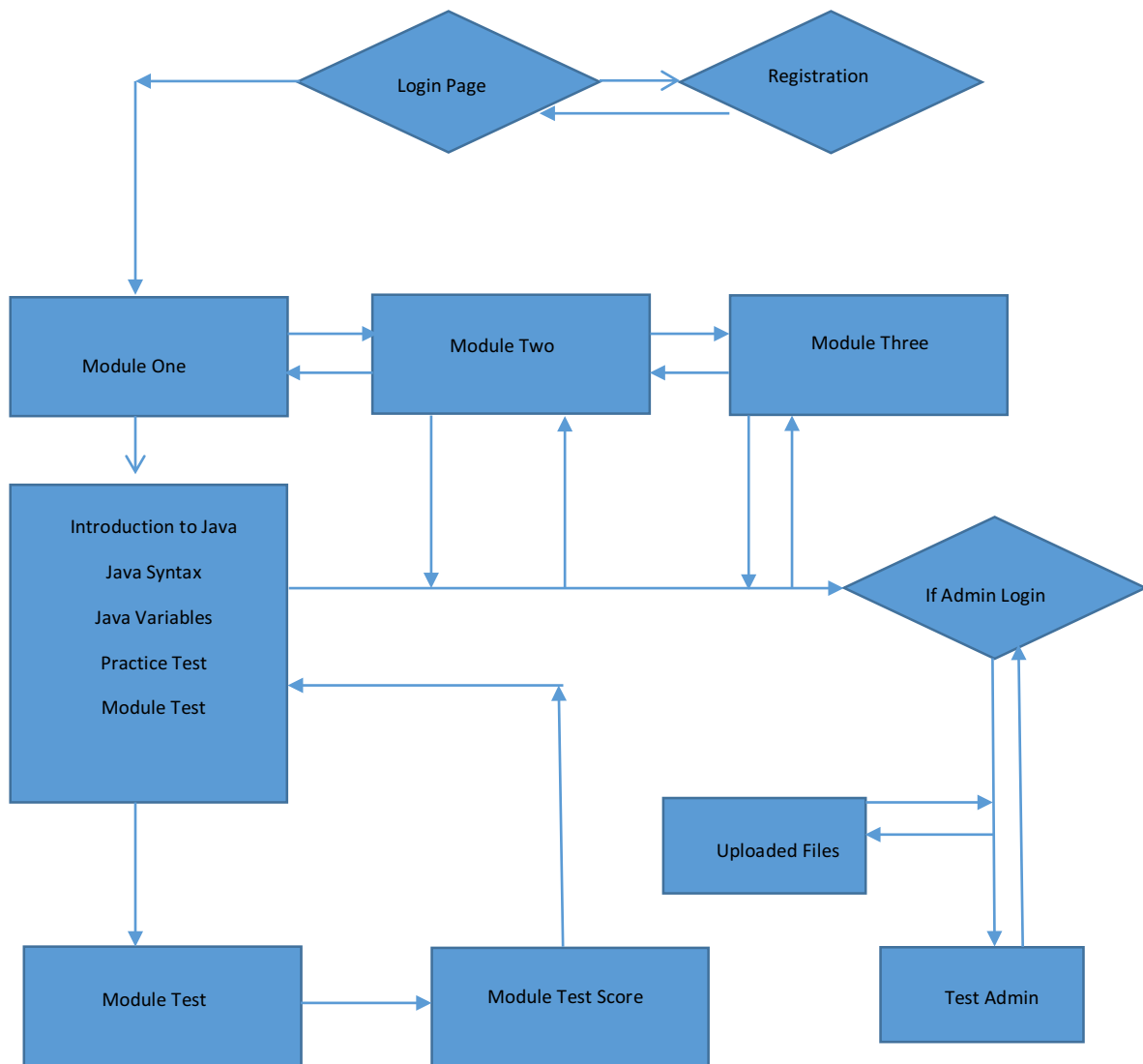


Figure 10 shows the final sitemap for the web application. Not all of the learning material, that follows the Masters syllabus, has been included within the scope of the project, as a result only Module one has been completed. Module one includes three sections along with two tests, the first is a practice test created in JavaScript and the second is a module test created in PHP that has the function to save student test scores to the project database.

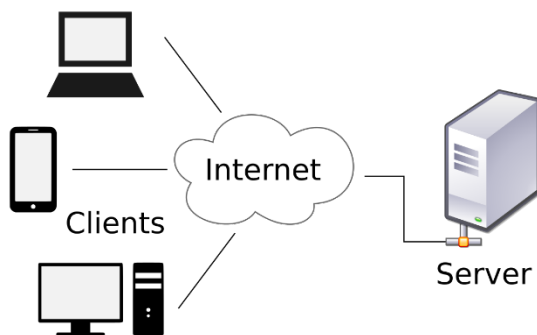
4.8 Client and Server Side Scripting

To create the web application a client-server relationship was maintained. This has been done by storing all of the web application files locally, on the project owner's personal laptop. The client sends a request to the user through the local server to access the web applications files, which has been implemented using the XAMMP web-hosting suite. The server then sends the necessary files that have been requested by the client.

To ensure the necessary steps were taken to safeguard against any risk of loss of data or data corruption and to meet key system requirements, the entire website project with all client and server files, along with any information to create the database tables has been stored in a GitHub repository named Interactive Java Learning Resource. This is described in more detail in section 5 implementation.

4.8.1 Client/Server Relationship

Figure 10 shows the relationship between the Client and the Server



4.8.2 Relational Database Design & Methodology

As the creation of the database was the sole responsibility of the project owner rather than in meetings with the key stakeholder, as was the case in the design of the user interface. It was then important to follow a suitable design methodology for creating and designing the database. The

methodology chosen was to attempt to follow the IEEE Standard (Institute of Electrical and Electronics Engineers Standards Association) 830 guidelines. These guidelines are not ideal for creating the functional requirements of a small project database (Silberschatz, Korth, Sudarshan 2011) however some of the key guidelines can be followed such as covering functional and non-functional requirements, general constraints and user characteristics (The IEEE standard for Requirements Overview, 2008).

The steps involved for creating the relational database for the project involved:

- Gathering all the required user related data
 - This involved looking at the key system requirements of the web application and deciding which data was necessary to store in the database tables.
 - At a minimum the database should hold data on student registration information such as usernames, passwords and email addresses.
 - Once this data has been gathered then other data areas was able to be gathered such as test scores.
- Create a conceptual schema of the database through an entity relationship diagram
 - Provides a detailed overview of the database system.
- From the database designing create a set of functional system requirements was drafted for the database.
- Organize the required data into relevant tables.
 - Using appropriate attributes for the data gathered for the database.
 - As a minimum structure would include a table for user registration, a table for user test scores.
 - Ensure the database tables makes correct of primary and foreign keys.
- Make use of normalization process to at least second normal form (2NF).

4.9 Database Schema

As stated above, as a minimum, it was decided that the database should have at least two function tables, one for the users of the website and one for their module test scores. By creating

these two tables key functional requirements for the web application were met such as offering a personalized learning environment and giving students the opportunity to assess their learning and performance through tests. An entity-relationship diagram is presented in figure 11.

Figure 11 Entity Relationship Diagram.

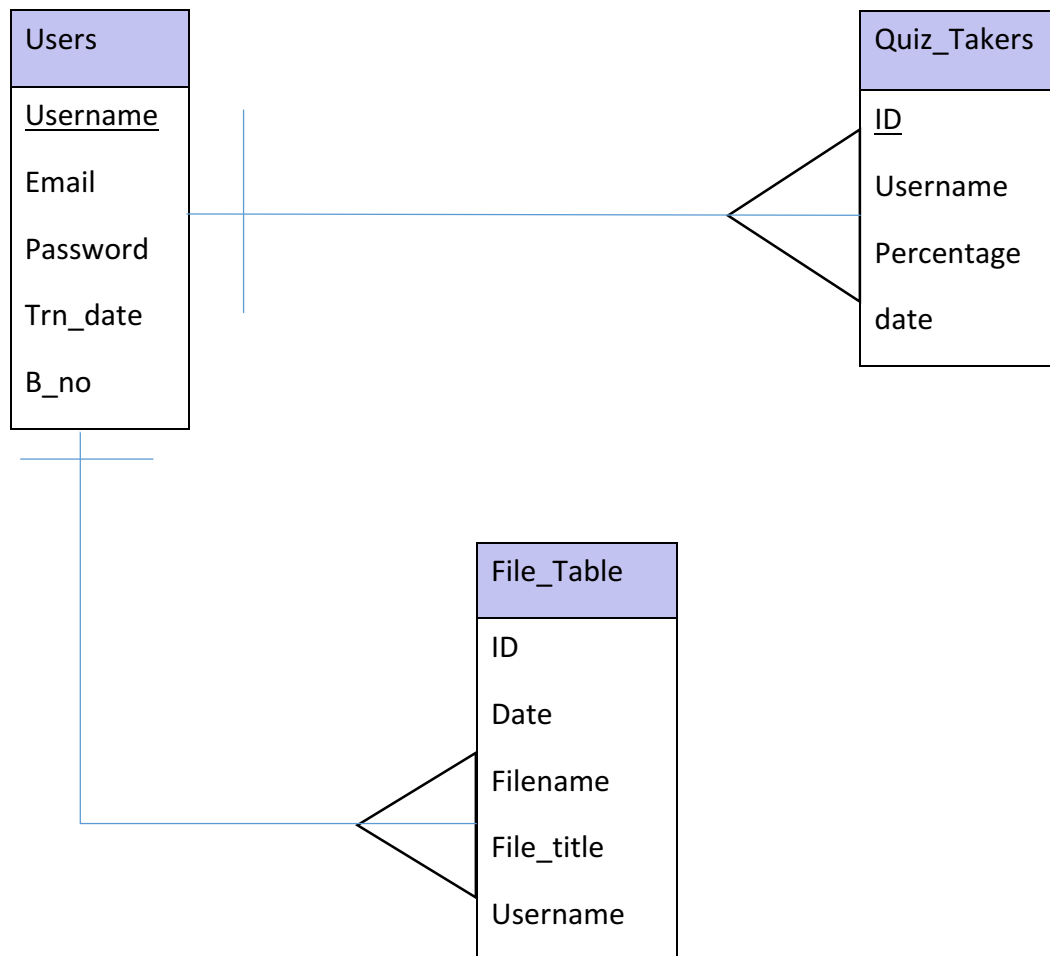


Figure 11 shows the three main tables of the project database. The first table is for users and stores registration data. The second table is for the test results named Quiz_Takers and stores data on the test scores that students have completed. The last table is used to store data on files that have been uploaded to the web application. In the Users table the Username attribute is the primary key of the table. In the Quiz_Takers table the primary key is the ID attribute which has the auto-increment features meaning that each time a new record is added to the table the

ID increases by one. The username attribute in the Quiz_takers table is a foreign key which points to the username attribute in the users table. In the file table the ID attribute is used again as the primary key with the foreign key username pointing to the username attribute in the user table. The user table has a one-to-many relationship with both the Quiz_takers table and the File_Table. This means that one student may have many test scores in the Quiz_takers table and one student many have many files uploaded to the web application.

The following shorthand representation of the database structure highlights the foreign and primary keys of the three main tables of the database:

- Users (username, password, email, trn_date, b_no)
- Quiz_Takers (ID, username*, percentage, date)
- File_Table (ID, username*, fille_name, file_title, date)

4.9.1 Module Test Tables

The module test for students to complete was created using PHP so that the students test scores can be saved to the project database. Two tables made up the testing system for the web application. The first table was named Questions and stores data on the questions used for the test. The second table was named Answers and stores data on the relevant answers for their respective questions. The shorthand notation for both these tables are shown below:

- Questions (ID, question_id, type)
- Answers (ID, question_id*, answer, correct)

In the Questions tables the question_id attribute is used to distinguish which question group the question belongs to. This is then referenced in the Answers table by the question_id foreign key which is used to match the answer to the appropriate question. In the Questions table there is a type attribute which is set to either tf, for a true or false question, or mc, for a multiple choice question. The correct attribute in the Answers table is used to distinguish which answer is the correct answer. This has been achieved by using either a 1 or a 0 to distinguish between the correct and wrong answers.

4.10 Other Tables

One other table was used to display a set of Java tips that can be seen in the Jumbatron feature of the main page in figure 7. The shorthand notation of the table is seen below:

Jtips (ID, tip)

4.11 Database Functional Requirements

The following functional requirements were drafted by the project owner to ensure that the creation of the database was a success.

- Database system should store all data into the relevant database tables without any problems.
- The database system should offer the facility to modify and update any data passed from the web application.

4.11.1 Database Non-Functional Requirements

The following non-functional requirements were drafted for the database:

- The database should have an acceptable response time.
- Database should have a high level of application security to deal with threats such as SQL injection attacks and malicious threats.
 - Use of password encryption such as MD5 PHP feature.

4.12 Summary

This chapter has looked at the design of the user interface as well as the design and implementation of the project database and the relationships that the database tables have with one another.

Implementation

Introduction

This chapter will first provide details about the necessary hardware and software that was used in the creation of the web application. This chapter also explains the software development cycle that was used to implement the web application. This chapter also includes key sections of code that has been used in the creation of the web application.

5.1 Hardware and Software

A personal desktop computer built with Intel Core i5-4570 CPU @ 3.20GHz with a Windows 10 64-Bit operating system as well as a personal laptop with Intel Core i3-4010 CPU @ 170GHz with a Windows 10 64-Bit operating system. The desktop machine was used for the majority of coding and implementation whereas the laptop was used for web application demonstrations to the project stakeholder.

Atom Text Editor with a built-in programming syntax highlighter and Notepad++ were used to program the web application. These text editors were chosen as they are easy and free to use.

Google Chrome, Mozilla Firefox and Microsoft Edge were the browsers chosen to test the implementation of the web application. Google Chrome was especially chosen as it offers a useful and free developer's tool which has made designing the web application a lot easier.

All of the web application's files have been stored locally on both the personal and desktop computers. XAMMP web-server suite has been used to serve the web application. This was chosen as it is free to use and widely available.

5.1.2 Client-Side Programming Languages

The client-side programming languages used to create the web application are:

- HTML (Hypertext Markup Language) was used for describing the structure of the webpages.

- CSS (Cascading Style Sheets) was the language used for describing the presentation of the web pages. This includes coloring, font styles and layouts. The majority of CSS scripts were kept in separate CSS files or within HTML layout files and then included in other files when necessary. There are some instances of smaller CSS scripts being used in individual web pages.
- JavaScript was the high level programming language used to add effects, interactivity and behavior to the web application. Some examples of JavaScript in action included the practice test, button functionality and more interactive features of the web application.

5.1.3 Server-Side Programming Languages

The server-side programming languages were used in the creation of the web application:

- PHP (Hypertext Preprocessor) language was used to execute server-side functions such as connecting to the project database, retrieving information from the database and displaying onto the web application. PHP allowed for other files, such as the HTML and CSS layout files, to be included into other, individual files, reducing the need to rewrite code. This was done using the PHP require and include functions.
- MySQL was the relational database management system used to create, store and maintain all the necessary database information. MySQL works along with PHP to send data from the client to the database located locally on the machine. Although MySQL is now deprecated with PHP 5.0 (PHP Manual, 2016) it was the database management system the project owner is most familiar with. With the intense learning required for learning web development, it was decided, by meeting with the key project stakeholder, that MySQL would be ok to use for this project.

5.1.4 Other Programming Systems

- Bootstrap is a free and open source front-end framework that has been used for designing and creating most of the user interface for the web application. Bootstrap has been used

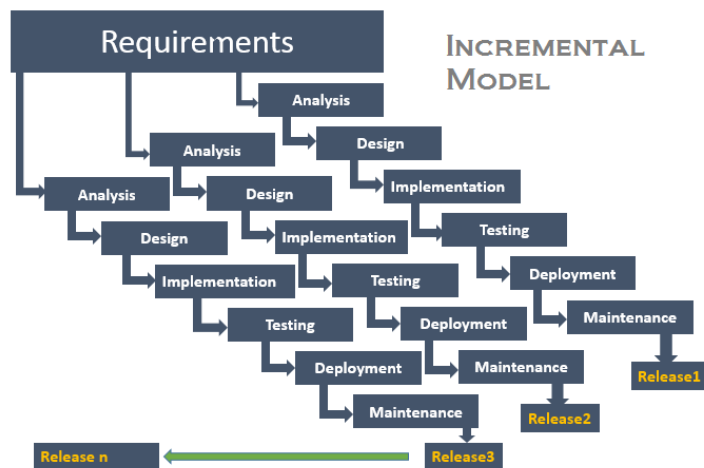
to add effects and styling to the buttons, navigation bar and overall content of the web application.

- JQuery is a cross-platform JavaScript library used to create certain aspects of the web application. The Ajax feature of JQuery was used in the second iteration of the web application to create the form for creating the module test before it was switched to PHP in the final iteration.

5.2 Software Development Model

The chosen software development model followed the incremental development model. By using the incremental model, the final product has been developed and presented to key project stakeholders in small increments. The Incremental model was chosen as it avoids the 'Big Bang' effect in development (in which no development happens for a long period of time), instead of building software, the software grows through iterations (Vilet, 2011) Figure 12 shows how the incremental development model works.

Figure 12



With each release, or increment, an iteration of the web application was developed, following the same waterfall process with each increment. As stated, the project had three main releases. These three releases served as project milestones in three main versions of the web application were presented to the key project stakeholder. In the actual development of the entire web application there has been a higher number of smaller iterations of the web application. For each

project deadline there was between 3 and 5 iterations of the web application. These iterations are described in table 5 in section 5.3.

5.3 Incremental Iterations

With each increment the same process was followed starting with analysis, design, implementation and then some minor testing to ensure the features that were implemented in the increment were developed correctly. Table 5 briefly describes the development involved in each increment.

Increment Number	Iteration Features	Code used	Comments
1	Basic layout for the homepage including navigation bar and sidebar.	HTML CSS Bootstrap	Layout works fine and navigation to different webpages achieved.
2	Create containers and wells for the learning information as well as the ability to toggle the sidebar.	HTML CSS JavaScript	Problems with expanding wells
3	Implement color scheme into the homepage	CSS	This is the first final iteration seen in figure 3 and classed as the first release of the web application
4	Change the layout of the homepage so that it is one webpage rather than multiple pages. Initial database tables created	HTML CSS JavaScript MySQL	Based on the user feedback that was gathered the entire user interface was changed
5	Design login screen	HTML CSS	

6	Create backend login and registration system for user accounts and insert data into tables using the login function.	PHP MySQL	
7	Create file system to upload files	PHP MySQL	This was the second release of the web application
8	Create more interactive learning features through embedded videos and links to other web pages. Implementation of Admin system for lecturer.	HTML JavaScript	
9	Create practice test for students to work through before module test	JavaScript	
10	Create module test that saves scores to the project database	PHP MySQL	This was the last increment that produced the third and final release of the product.

Section 5.3.1 goes into more detail of the development of each iteration starting with the fourth increment. The fourth increment has been chosen as the starting point of the vast amount of development required as this was the point in which the layout of the web application changed and when most of the development work started.

5.3.1 First to Third Increments

These increments involved creating a prototype iteration of the web application. The changes involved in the design have been detailed in section 4. Steps involved in the first three increments involved:

- Downloading all necessary software for the creation of the web application.
- Creating the necessary files for the development of the web application.

- One for CSS layouts
- One for JavaScript files
- One for PHP functions
- Main folder for all other files
- Creating a basic layout for the homepage using navigation and side bars with links to each of the learning topics.
- Creating basic color scheme using CSS.
- Creating containers and wells using Bootstrap framework to hold learning information and add a sense of interactivity to the web application.

5.3.2 Fourth to Seventh Increments

As stated, the development of the web application took a shift after the third increment. The development steps involved in the fourth to seventh increment included with some of the key sections of code included in the following figures:

- Download the necessary software for the backend development of the web application
 - XAMMP web-suite was installed which allowed for the creation
 - Move all web files to the htdoc section of XAMMP web suite in order for the backend PHP files to work correctly.
- The initial database tables were created to store user account data as well as creating a connection between the web application and the project database.
- Login and registration system created to implement the ability to create personalized user accounts.
 - Login page created using HTML with a PHP login reg file included within the login file
- Design of the single page layout making using of Bootstrap front end framework
- Interactive buttons and learning resources added.
- Actual learning material was created using HTML with added interactivity from JavaScript features.

Figure 13 shows the code used to create a connection between the web application and the database using PHP called db.php. This file was used on any web page that interacted with the database, reducing the need to rewrite code.

```

1 <?php
2 //php script that opens a connection to register database
3
4 $servername = "localhost";
5 $username = "root";
6 $password = "";
7 $dbname = "register";
8
9 $connection = mysql_connect($servername, $username,$password,$dbname );
10
11
12 if (!$connection){
13     die("Database Connection Failed" . mysql_error());
14 }
15
16
17 $select_db = mysql_select_db('register');
18 if (!$select_db){
19     die("Database Selection Failed" . mysql_error());
20 }
21
22 ?>

```

- This file creates a connection to the database using the information saved into variables on lines 4 to 7.
- If no connection to the database can be made then an error message is displayed.

Figure 14 shows the PHP file used to login a user into the system.

```

1 <?php
2
3
4 //include ('auth.php')
5 session_start(); //need to manually start session as auth.php will not work
6
7
8 // If the form is submitted then add username and password to global variable
9 if (isset($_POST['username'])){
10     $username = $_POST['username'];
11     $password = $_POST['password'];
12
13
14     //stripslashes and real_escape_string for both the username and password to help prevent sql injection attacks
15     $username = stripslashes($username);
16     $username = mysql_real_escape_string($username);
17     $password = stripslashes($password);
18     $password = mysql_real_escape_string($password);
19
20 //Checking is user existing in the database or not. If they are not redirect to login page
21 $query = "SELECT * FROM `users` WHERE username='$username' and password='".md5($password)."'";
22 $result = mysql_query($query) or die(mysql_error());
23 $rows = mysql_num_rows($result);
24 if ($rows==1){
25     $_SESSION['username'] = $username;
26     header("Location: index.php"); // Redirect user to index.php
27 }else{
28     echo "<div class='form'><h3>Username/password is incorrect.</h3><br/>Click here to <a href='login.php'>Login</a></div>";
29 }
30 }else{
31 }
32 ?>

```

- The session_start() function creates a PHP session once the user has successfully logged into the web application.
 - Allows for session variables to be passed amongst web pages.

- The .md5 hash function on line 21 was used here to decrypt the password from the database that has been encrypted in the registration system.

Figure 14 shows the registration PHP file called reg.php which registers the data from the registration html form and inserts this data into the database.

```

1 <?php
2 //Interactive Java Learning Resource. Jason Wallace. Last Edited Wed 10 Aug 2016
3 //Registration PHP function included in registration.php
4
5
6 require('/phpfunctions/db.php'); //require db connection
7
8 // If the form is filled in and submitted then insert the following values into the users table
9 // Helps protect from SQL injection through removing escape characters and slashes
10 // MD5 Hash algorithm to encrypt password for the user
11 if (isset($_POST['username'])) {
12     $username = $_POST['username']; //username
13     $email = $_POST['email']; //email
14     $password = $_POST['password']; //password
15     $b_no = $_POST['b_no']; //student reg number
16     $username = stripslashes($username);
17     $username = mysql_real_escape_string($username);
18     $b_no = stripslashes($b_no);
19     $b_no = mysql_real_escape_string($b_no);
20     $email = stripslashes($email);
21     $email = mysql_real_escape_string($email);
22     $password = stripslashes($password);
23     $password = mysql_real_escape_string($password);
24     $trn_date = date("Y-m-d H:i:s");
25     $query = "INSERT into `users` (username, password, email, trn_date, b_no, user_level, account_status) VALUES ('$username', '".md5($password)', '$email', '$trn_date', '$b_no', '0', '0')";
26     $result = mysql_query($query);
27     if($result) {
28         echo "<div class='form'><h3>You are registered successfully.</h3><br/>Click here to <a href='login.php'>Login</a></div>";
29     }
30 }
31 ?>

```

- Data passed into the database using line 25 in which an insert statement is used to pass the php variables taken from the html registration form into the database.
- Once the user has registered successfully they are then prompted to login to the system.

Figure 15 shows the redirect php function that is included in every web page. This is to ensure that only those registered users who have logged in can use the web application

```

1 <?php
2
3 //PHP script to authenticate user
4
5 //Start the session
6 session_start();
7
8 //If there is no valid session redirect to login page
9 if(!isset($_SESSION["username"])) {
10     header("Location: login.php");
11 }
12 //exit the session
13 exit(); }
14 ?>

```

- Redirects users to the login page if there is no valid session.

- The admin panel is only accessible for the admin user by using PHP session variables to distinguish between admin and student users.
- If admin does log in to the system, then a Bootstrap accordion bar is present in which the admin can access student files and the module test admin section.

Appendix 5 shows the code used in the creation of the interactive JavaScript quiz

5.4 Development Changes

At the start of the original design and analysis work the chosen development methodology for the project was to follow an Agile methodology development structure however as the project began to develop it was apparent that agile was not the suitable development methodology to choose. This was because agile is more focused towards team development and as there was only one developer working on this web application it was decided that the project would follow the incremental development model.

5.5 Summary

This chapter has looked at how the incremental development methodology was applied to the development of the web application. Key sections of code were included to highlight the work that went into creating the web application. The chapter also looked at how each iteration of the web application changed with each increment.

Testing and Evaluation

Introduction

This chapter describes the approach that has been taken to testing and evaluating the final iteration of the web application. The evaluation section assesses the overall value of the final iteration of the web application and evaluates any criticism that was received during the testing phase of the project.

6.1 In-House Testing

Not only was the web application tested against the functional and non-functional requirements but in-house testing was done to ensure the web application functioned correctly. As the project has followed the incremental software development model, testing was carried out at the end of each iteration with the newly implemented features being tested on their functionality. To successfully test each iteration of the web application a table was used for each increment. As most of the web applications core functionality and features were implemented from the fourth increment onwards, documented testing was carried out from the fourth increment. Testing for the web application took a fault-based testing approach which focused on detecting any faults that may have occurred when using the web application. Testing from increments 1 through to three was done as each new feature was added and was not documented, this was because only minor features were added to the web application at this point in the development cycle so they could just be tested there and then. Testing has been carried out amongst the four main browsers.

Code inspections were carried out at the end of each increment. Fagan inspections (Vilet 2011) have been used to assess code statement by statement. This type of inspection has been used as it allows for the successful detection of various faults with the code that has been used. This can include bugs such as wrongful use of data: variables not being initialized or faults in the declaration of variables, faults with relational expressions and operators as well as faults in control flow such as infinite loops. Although this type of testing is usually carried out by a team of testers it has been useful for this small web application.

Table 6 shows the testing criteria for the fourth increment.

Testing Step	Function	Edge	Chrome	Safari	Firefox
1	Can use navigation bar to easily move to each section learning topic				
2	Navigation bar highlights depending what learning topic is currently being looked at				
3	Any interactive features such as videos and text documents load without any problems				
4	Responsive to screen size. This includes navigation bars text, buttons any other features of the main home page.				

Table 7 shows the testing criteria for the fifth and sixth increments

Testing Step	Function	Edge	Chrome	Safari	Firefox
1	Connection made to the database correctly, error message displayed in the even no connection is made				
2	User can successfully register to the website with the relevant information being saved to the database tables. Password encryption carried out successfully				
3	Any attempts to access web content without logging in should redirect the user to the login screen				
4	Login form and relevant PHP functions should work correctly.				
5	Use of PHP session variables should clearly state which user is logged into the web application				
6	Java tips table should show a random tip from the table onto the main home page each time				
7	All web content should remain responsive to screen size including login forms				
9	Modal dialog boxes should open and close correctly				
10	All interactive features should work correctly without any issues				
11	Students able to upload files correctly with all files saved to the correct file				

Table 8 presents the testing criteria for the eighth increment

Testing Step	Function	Edge	Chrome	Safari	Firefox
1	Admin panel only available to admin login with all links navigating the user to web pages for the admin. Web pages should be blank at this stage until development for each page has been completed				
2	Admin panel should be collapsible without any problems				
3	Non-admin users should not be able to access admin webpages when not using the admin panel				
4	Responsive to screen size. This includes navigation bars text, buttons any other features of the admin section of the web application				

Table 9 presents the testing criteria for the ninth and tenth increments

Testing Step	Function	Edge	Chrome	Safari	Firefox
1	JavaScript quiz should work correctly with the right number of correct answers displaying at the end of the quiz				
2	Pass mark tested at different levels with a link displaying if pass mark has not been achieved				
3	Module test should save questions and answers to the relevant database tables correctly without any issues.				
4	Admin feature to reset the module test should successfully truncate the relevant database table				
5	Module test completed under different user accounts to ensure that the test percentage and date time is saved to the database table				
6	Variety of true or false and multiple choice questions tested to ensure that they are displaying correctly and are stored to the database without any issues				
7	All features of the website work correctly by working through all aspects of the site as a new user				
9	The web application meets all of the functional and non-functional requirement drafted during analysis.				

6.2 External Testing

The same four students who carried out the initial survey of the web application after the third increment, were again asked to test and evaluate the web application. The four students were asked to test every aspect of the web application this ranged from creating user accounts, reading through the learning material and then taking the practice and module tests. The four students were then asked to complete a survey. The four students were asked to simply rate four areas of the web application out of a mark of 10. The four areas include the user interface, login system, testing system and how likely they would recommend the web application to next year's students of the Masters course. All four of the students tested the web application on the same laptop with the Google Chrome browser. They were then asked to complete the survey and add any additional comments based on what they would like to see added to the web application in future iterations.

6.2.1 Survey Results

The results of the survey were very promising, with all four of the students giving very positive feedback on the web application. The results of how the students rated the web application are presented in table 10.

Table 10 Survey Results

Student Number	User Interface	Login System	Testing System	Recommend
1	8/10	8/10	8/10	Yes
2	10/10	8/10	7/10	Yes
3	10/10	7/10	7/10	Yes
4	9/10	8/10	6/10	Yes

Table 10 shows some very satisfactory results with all four students saying that they would recommend the web application to new students learning Java programming. The user interface yielding the highest ratings with the testing system being the lowest rated of the three sections surveyed.

6.3 Web Application Evaluation

The survey results did yield some satisfactory results as displayed in table 10, however individual comments left by some of the student testers indicated some problems with the final iteration of the product. All four of the users indicated that there were problems when completing the module test for example one of the users described how they were logged out of the web application whenever they had finished with the module test. Under closer inspection it seemed that everything was working correctly with the time and date as well as percentage achieved in the module test was saved to the relevant database table. This appears to be a bug in the PHP code of the final iteration. Another student tester reported that the interface for the module test could have been designed better in particular the web page that displays the users final mark.

Another issue of concern for the web application was that one of the student testers indicated that there was limited interaction between the user and the lecturer through the use of the web application. One of the key requirements for developing a solution to the problem was to create a blended learning environment that acted as an aid to the Masters course. The web application could provide a better solution to the problem by offering users the ability to communicate with the lecturer directly through the use of the web application. This could involve the implementation of a discussion forum or an instant message system in which both students and lecturer can communicate about problems they are facing, during their learning of the topic.

Another issue with the final iteration of the web application that was picked up in the comments of the four student testers, was that although the web application did have a number of interactive learning features that the students found appealing, there could have been more of a variety of learning materials. Some ideas put forward by the student testers included interactive

learning games in which they are given a segment of code with various syntax errors that need to be corrected and then compiled.

6.4 Requirement Overview

Overall the final iteration of the web application meets every one of the functional and non-functional requirements that were presented in chapter 2 of this report. However, some recommendations can be made for future iterations of the web application so that it does more to achieve the requirements. These recommendations are listed in chapter 7.

6.5 Summary

This chapter has presented the testing phase of each increment involved in the development process of the web application. This chapter has looked at the short survey that was handed out to the four student testers of the application and an evaluation of any issues that are present with the final iteration of the project. This chapter then looked at how the final product met the functional and non-functional requirements that were listed in chapter 2.

Conclusions

Introduction

This final chapter summarizes the overall project and how successful the final iteration of the web application has been. This chapter also looks at how the web application can evolve and change during future iterations as well as any recommendations for changes to the system. Finally, this chapter looks at how successful the solution to the problem has been.

7.1 Project Summary

The first part of this project involved conducting background research on blended learning environments and the problems that students have when learning the Java programming language as beginners. The research findings highlight various problems that students having when attempting to learn the language as part of an intensive course like the Masters in Professional Software Development at the University of Ulster. With such an intensive learning schedule students can find themselves falling behind or failing to understand important aspects of the programming language. The background research highlighted the advantages that blended learning environments have when they are used in conjunction with traditional classroom teaching techniques.

Although the project has been successful in highlighting the advantages of blended learning environments others areas could be explored when researching the benefits of online learning. If faced with the same problem again, other areas of research could be explored such as the benefits of adaptive learning environments. The entire project could shift focus to adaptive learning and the interactive techniques that are used to give each individual student personalized feedback. As stated in the background research, individual students have different learning needs so it would be beneficial to develop the research on adaptive learning.

The project then examined existing solutions to the problems through a competitive analysis of four learning environments that solely covered computer programming and those which had the subject included in their syllabus. From this competitive analysis it was decided that an

interactive blended learning environment would be the most suitable solution to the problem. This learning environment was named the Interactive Java Learning Syntax Resource and was designed to work as a free blended learning environment for those students enrolled in the Professional Software Development course. The project has then described how the most suitable solution to the problem would be for the learning environment to take the form of a web application which would offer students a personalized learning tool that they can log in to and work at their own pace. The main function of this learning environment is to act as a study aid to the Masters course.

The design of the web application and its user interface was centered on creating a visually appealing user interface with a sound level of human computer interaction and interactive learning resources through the use of video tutorials and links to external learning tools. This was to offer students an interactive learning experience, while at the same time, offering students personalized learning resources selected by their lecturer. The design of the web application has been influenced by existing design guidelines set out by W3C. This has created a high level of accessibility and usability for the web application. The web application does an excellent job of catering to disabled users by using W3C guidelines.

Client-side programming was achieved using well established programming languages, included was HTML, CSS and JavaScript. The back end server programming was achieved by making use of scripting languages like PHP which enabled the web application to connect to a project database. The project database has been implemented using MySQL and using phpMyAdmin. These software resources were provided by the XAMMP web-server suite. By creating a backend framework for the web application the project has been able to develop a module test, with students' performance being stored in the database. This has been beneficial for both the students and the lecturer when assessing individual performance and understanding of Java Programming.

The implementation of the web application was achieved by following the incremental software development model. By following this model there was a constant focus on the development of the web application. There were no gaps of time between development during the various increments of the project. This allowed for fresh ideas to be constantly designed and

implemented into the web application. With testing happening at the end of every increment this freed up more time towards the end of the project to focus on features that were not previously explored, such as the feature to be able to upload files as well as the admin panel features.

The testing of the final iteration of the web application took the form of a survey questionnaire to four students who had previously gave input on the design of the user interface during the first iteration of the web application. The four students responded positively to the web application with all four students saying they would recommend the web application to new students. Some areas of improvement were gathered from the surveys such as increasing the communication between student and lecturer through the web application and making some features more interactive.

7.2 Project Aims

All of the objectives declared at the start of the project have been met with a variety of success.

- Background research was conducted on the topic of blended learning and the benefits that they offer.
 - Future versions of the project could research adaptive learning environments and online only learning courses.
- Existing solutions were examined and their pros and cons assessed with useful features of all four solutions inspiring some form of the design of the web application.
 - Future versions of the project could look at more solutions than just four.
 - Based on the research of adaptive learning environments assess how those solutions attempt to solve the problems of learning Java.
- Met regularly with the key project stakeholder to make sure that the requirements were met.
 - In the case of this project, the project supervisor was the key stakeholder. Future versions of the project could involve more lecturers and supervisors to gain their input on the project.

- Successfully designed and created a functioning web application which provided interactive and personalized learning resources to students learning Java programming.
 - All four student testers would recommend the web application to new students.
 - Based on feedback future versions of the project could add more interactive features or even implement other learning topics that are involved in the Masters course such as Database Systems, Operating Systems and Computer Hardware modules.
- Successful in-house testing of the web application and its core features as well as testing carried out by four current students of the Masters course. All core features of the web applications user interface and back end framework have been tested successfully.

7.5 Recommendations

Some recommendations for future iterations have been documented throughout this chapter on how the web application can be evolved. These have included:

- Conducting more background research on adaptive learning environments and implementing these benefits into the web application.
- Having more personalized feedback and learning resources for students.
- Having more communication options between lecturer and student. This could take the form of an instant message program or even a discussion forum in which students can discuss learning Java programming.
- Add more learning modules to the web application.
- Create the backend framework based on SQLite or PDO instead of MySQL as it is no longer supported by PHP 5.0.
- Have more version control by making use of Github more than it was used in this project. Github was only used to store the project files. It could be used for multiple people to work on the project at once.

7.6 Expandable Web Application

This project has created an interactive learning resource tool that can be expanded on with future iterations. Once a lecturer has been shown how the web application works, they have full control over the learning material as well as the testing functionality. The web application provides a framework which can be built upon and can be used for other learning topics not just Java programming.

7.7 Summary

Overall this project has been a success in meeting all the objectives declared at the start of the development of the project. Although some work needs to be implemented to improve the functionality of the web application it fulfills its role as an interactive learning resource tool for students learning Java programming.

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Appendices

Appendix 1: Rich Picture Diagram of the Problem



Appendix 2

Table 2- Android application Pros and Cons list

<u>Pros</u>	<u>Cons</u>
Can be used on the go. For example, if a student is travelling to university on the train they could make use of the learning environment on their way to the University.	Very limited screen size for this type of learning environment. Could lead to user interface problems and poor human computer interaction (HCI)
	Not all students may have access to a smart phone or tablet device
	Would need to design the application for all forms of screen sizes and devices
	By creating an android application, it would alienate any student who uses Apple devices such as Ipads or Iphones
	Would require ongoing care and development due to the development of new mobile devices and their operating systems
	No clear set of standards exist for mobile application development

Appendix 3: Survey handed out after third increment- Info Sheet

Page 1/3

Project Student: Jason Wallace

Project Supervisor: Gaye Lightbody

Contact Email Address: Wallace-J15@email.ulster.ac.uk

I would like to invite you to take part in a short survey aimed at the design, implementation and testing of a new website. The website will provide an online interactive learning environment to assist students learning Software Development as part of the Masters course at the University of Ulster. The survey is being carried out in partial fulfilment of my MSc project and your involvement would be very much appreciated.

The survey involves you to use the website that has been developed and rate two key areas out of 10. These areas are the user interface design and the interactivity of the website's functions. You are also invited to write down any additional comments that you may have. Please be advised should you choose to partake in this survey, under the Freedom of Information Act, you will have the right of access to data which you have contributed. Every effort will be taken to ensure that all personal data will be removed from information that will be gathered for the purposes of this research.

Hard copy data will be stored securely only until the successful completion of this program of study and thereafter safely destroyed.

Please be aware that participation is not compulsory and even if you consent to take part you have the right to withdraw from the survey at any time.

I would very much like to thank you for your time in reading this information sheet and would be very grateful should you choose to take part in the survey.

Many Thanks

Jason Wallace

Appendix 3: Survey handed out after third increment- Survey

Page 2/3

Project Student: Jason Wallace

Project Supervisor: Gaye Lightbody

Contact Email Address: Wallace-J15@email.ulster.ac.uk

Thank you for taking time to demonstrate the Interactive Java learning resource tool. As described in the information sheet there are two areas in which you should give a mark out of 10. As a reminder these areas are the user interface design of the website as well as the interactivity features. The interactivity features include any ways in which the user interacts with the website to access learning resources.

On a scale of 1 to 10, with 1 being the lowest and 10 being the highest score how would you rate the implementation of the user interface of the website. User interface is use to describe the colour scheme, how everything is laid out on the screen and how easy it is to navigate through the website. Please circle.

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

On a scale of 1 to 10, with 1 being the lowest and 10 being the highest score how would you rate the interactive features of the website. Interactive features mean any way in which the user interacts with the website to access learning material. Please circle.

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

Appendix 3: Survey handed out after third increment- Comments

Page 3/3

Project Student: Jason Wallace

Project Supervisor: Gaye Lightbody

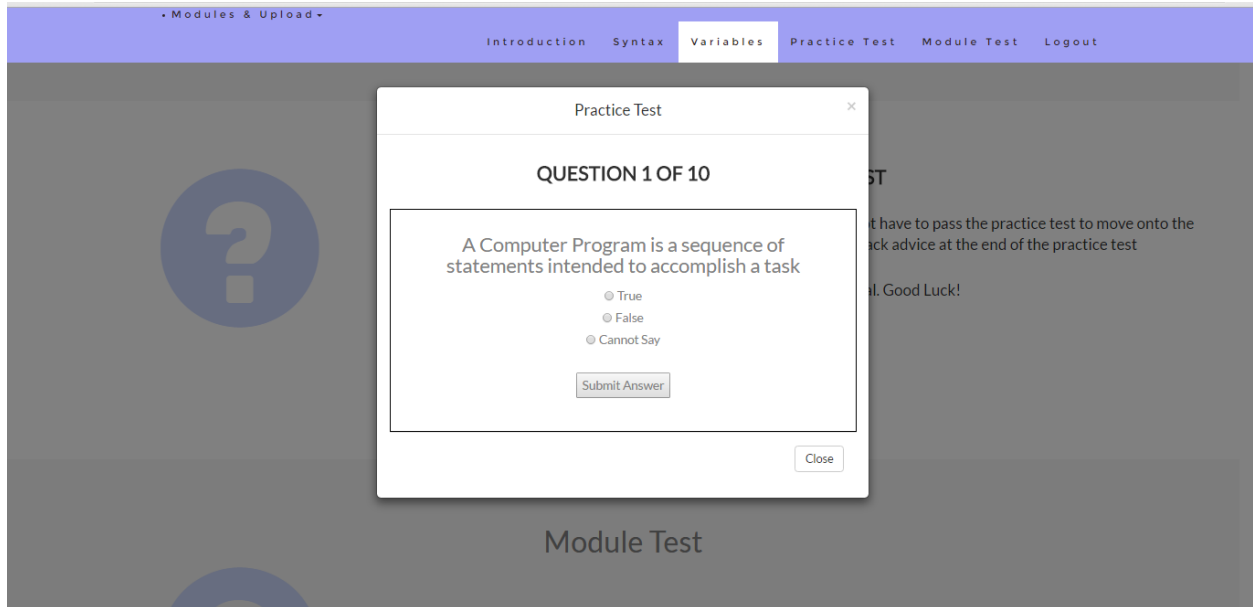
Contact Email Address: Wallace-J15@email.ulster.ac.uk

Is there anything that you particularly liked about the website?

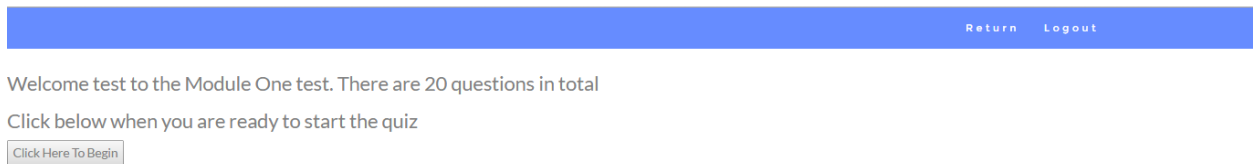
Is there anything that you did not like about the website?

Again, many thanks for taking the time. Your help has been very much appreciated.

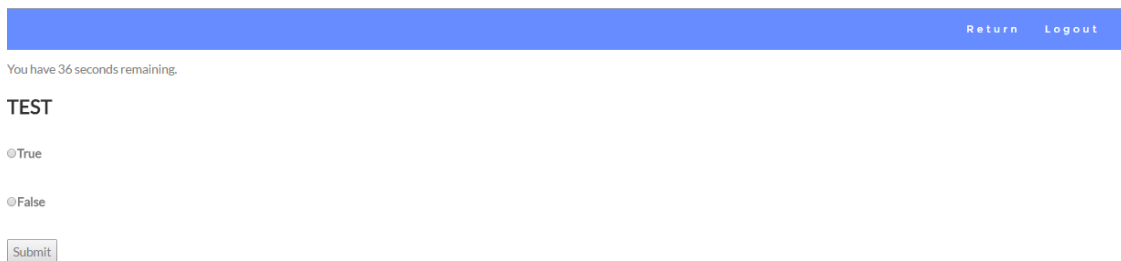
Appendix 4: Miscellaneous User Interface Screen Shots



Screen shot of the Practice Test user interface created using Bootstrap modal.



Screen shot showing the beginning of the module test



Screen shot showing a test question with the countdown timer

Upload File

Enter File Title:

[Choose file](#) No file chosen

Upload

User interface for the student file upload page

• Modules & Upload ▾

Introduction Syntax Variables Practice Test Module Test Logout

Welcome admin Your last visit was on Sun, Sep 11, 2016 07:06:31 PM

Java Revision Tip

A class identifier should be meaningful to the purpose of the program

Most Recent Module Score-

0

ADMIN Dashboard

WELCOME ADMIN. SEE BELOW FOR ADMIN FUNCTIONS

[Uploaded Student .java Files](#) [Module Test Admin](#)

Admin panel containing admin features for the lecturer and below is the webpage showing uploaded student files.

• Modules & Upload ▾

Introduction Syntax Variables Practice Test Module Test Logout

THIS IS A LIST OF UPLOADED CODE

Number	File Title	Delete
1	test.pdf	Delete
2	ffff	Delete
3	tomsfile	Delete

Appendix 5: JavaScript practice test code

```
<script>
```

```
var pos = 0, test, passMark = 10, test_status, question, choice, choices, chA, chB, chC, correct = 0;
```

```
var questions = [
```

```
  [ "A Computer Program is a sequence of statements intended to accomplish a task", "True", "False",  
  "Cannot Say", "A", "1" ],
```

```
    [ "Programming is a process of planning and creating a program", "True", "False", "Cannot Say",  
  "A", "1" ],
```

```
    [ "Java was initially developed by who?", "Intel", "Microsoft", "Sun Microsystems", "C", "1" ],
```

```
    [ "Java is currently on version ____", "9", "2", "8", "C", "1" ],
```

```
    [ "The output of the Java compiler is known as ____", "bytecode", "variables", "binary", "A" ],
```

```
    [ "Java is not platform independant", "True", "False", "Cannot say", "B", "2" ],
```

```
    [ "In Java each statement is terminated by a __", "Fullstop - .", "Comma - ,", "Semi-colon - ;", "C",  
  "2" ],
```

```
    [ "Syntax Errors are known as ____", "Compile Time Error", "Java Grammer Error", "Run time Error",  
  "A", "2" ],
```

```
    [ "Eclipse and IntelliJ are known as what?", "Java Development Kits", "Integrated Development  
  Enviornment", "Java Compilers", "B", "3"],
```

```
    [ "Java has a case sensitive syntax?", "True", "False", "Cannot Say", "A", "1" ],
```

```
];
```

```
function _(x){
```

```
    return document.getElementById(x);
```

```
}
```

```
function renderQuestion(){
```

```
    test = _("test");
```

```
    if((pos >= questions.length) && (correct >= passMark)){
```

```

        test.innerHTML = "<h2>Well done. You got "+correct+" of "+questions.length+" questions
correct. You can now move onto learning about Java Variables</h2>";

```

```

        _("test_status").innerHTML = "Test Completed";

```

```

        pos = 0;

```

```

        correct = 0;

```

```

        introTotal = 0;

```

```

        return false;

```

```

    }else {

```

```

        test.innerHTML = "<h2>You got "+correct+" of "+questions.length+" questions correct.
Please      try      reading      over      this      resource      before      continuing      \n
https://www.ibm.com/developerworks


```

```

        \n
https://www.ibm.com/developerworks


```

```

    }

```

```

    _("test_status").innerHTML = "Question "+(pos+1)+" of "+questions.length;

```

```

    question = questions[pos][0];

```

```

    chA = questions[pos][1];

```

```

    chB = questions[pos][2];

```

```

    chC = questions[pos][3];

```

```

    test.innerHTML = "<h3>"+question+"</h3>";

```

```

    test.innerHTML += "<input type='radio' name='choices' value='A'> "+chA+"<br>";

```

```

    test.innerHTML += "<input type='radio' name='choices' value='B'> "+chB+"<br>";

```

```

    test.innerHTML += "<input type='radio' name='choices' value='C'> "+chC+"<br><br>";

```

```

    test.innerHTML += "<button onclick='checkAnswer()'>Submit Answer</button>";

```

```

}

```

```

function checkAnswer(){

```

```

    choices = document.getElementsByName("choices");

```

```

    for(var i=0; i<choices.length; i++){

```

```
        if(choices[i].checked){
            choice = choices[i].value;
        }
    }
    if (choice == questions[pos][4]){
        correct++;
    }
    pos++;
    renderQuestion();
}
window.addEventListener("load", renderQuestion, false);
</script>
```