**James Bolch**

Supervisor: **Mr Thamotharampill Sutharssan**

March 2012

**A case study of programming design patterns for students to learn during education**

URL: **exp.ulse.net/james**

Word count: **Insert number (less than 14,000 not counting preamble and appendices)**

A dissertation submitted in partial fulfilment of the University of Greenwich’s

**BEng (Hons) Software Engineering**

Abstract

The Project intends to approach the use of design patterns in the course of programming and designing applications. The project will investigate each of the design patterns commonly used in programming, examining each in detail in the form of a case study, with demonstrations of their UML diagrams and demonstrations of how they are used, along with an explanation and equal demonstration of patterns that are more specific to certain uses. The study will provide material for a greater understanding of design patterns in programming, each with their advantages and disadvantages outlined in the report. The case study will also include comparative elements to compare and contrast each design pattern and its use. The study will also contact other students within the University in the line of Software Engineering to discuss and report the experience of students that learned and used design patterns in the course of their programme, along with their use of UML creation related to the patterns. All of the information gathered in research outlined will aid in the creation of a case study targeted specifically with design patterns in UML and programming code.

Preface

.

The Preface includes any relevant observations that do not belong in the project itself. It is here that the justification for the project meeting the undergraduate programme requirements and the National Qualifications Framework.

Acknowledgements

It is customary to acknowledge any substantial help, with either the project work or the report, from people and other informal sources

Contents

1 Introduction 1

1.1 Background Information 1

1.2 Project Scope 1

1.3 Aims and Objectives 1

1.4 Change Control 2

1.5 Overview 2

2 Literature Review 3

2.1 Introduction 3

2.2 Learning Methods 3

2.2.1 Introduction 3

2.2.2 The Learning Pyramid 3

2.2.2.1 Introduction 3

2.2.2.2 Retention 5

2.2.2.3 Conclusion 5

2.2.3 Repetitive Learning 5

2.2.4 Testing 6

2.2.5 The Human Factor 7

2.2.6 Conclusion 7

2.3 Design Patterns 8

2.3.1 Introduction 8

2.3.2 The different design patterns 8

2.3.3 Use of design patterns and their benefit 8

2.4 Legal Social Ethical and Professional Issues and Considerations 8

2.5 Key issues to use in the design and implementation 8

2.6 Conclusion 8

3 Review of Other Learning Solutions 9

3.1 Introduction 9

3.2 Codecademy 9

3.2.1 Overview 9

3.2.2 Appearance 9

3.2.3 Usability 10

3.2.4 Summary 11

3.3 ProProfs Quiz Maker 11

3.3.1 Overview 11

3.3.2 Appearance 11

3.3.3 Usability 12

3.3.4 Summary 13

3.4 Key issues to use in the design and implementation 13

3.5 Conclusions 14

4 Requirements Analysis 15

4.1 Introduction 15

4.2 Implementation 15

4.3 Functional Specifications 15

4.3.1 The Website must allow the user to take tests 15

4.3.2 The Website must show statistics from previous tests 15

4.3.3 The Website must show correct and incorrect answers 15

4.4 Non Functional Requirements 16

4.4.1 The interface appearance shall be clear attractive 16

4.4.2 The website shall be easily usable 16

4.5 Legal Social Ethical and Professional Issues and Considerations 16

4.6 Summary 16

5 Design of the Website 17

5.1 Introduction 17

5.2 Visual Design 17

5.3 Technical Design 17

5.4 Legal Social Ethical and Professional Issues and Considerations 18

5.5 Justification of Design 19

5.6 Summary 19

6 Development of the Website 20

6.1 Introduction 20

6.2 Implementation 20

6.3 Technical Problems 20

6.4 Testing 20

6.5 Summary 21

7 Evaluation 22

8 Conclusion 23

Appendix A - Project Proposal 25

Appendix B - Gantt Chart 26

# Introduction

## Background Information

The project was designed with active learning in mind, one problem some students face is the inability to use recently learned work in many applications, even such of coursework would brush over the particular topic once or twice and not have many uses during the year. Using multiple choice testing, the knowledge can be tested and retained with regular use without the need to do complex testing or work examples that some students may just skip over or not have the time to do with other work matters pressing ahead, the knowledge can be tested and statistics recorded, including what questions were wrong so they can later be examined in the informational sections of the website.

The idea came ahead with discussions held with students about the issue with the way work was deployed and taught, often knowledge not being retained due to it not being used. This is a problem within students, especially those that do suffer to retain the knowledge whom get their degrees but often forget large portions of what they were taught. The idea of creating the website with this project is intended to allow students to combat this problem and retain their knowledge, design patterns was selected to base the project on as a demonstration of the use of the website. This also provides a case study involving design patterns so this particular product could be used to assist students with learning design patterns.

## Project Scope

The project approached one of the key factors in design and programming of applications. It investigated each design pattern that is commonly used in programming, with each used in detail to form a case study which use the design patterns with assistance of UML onto a platform that can be used with students studying programming. The platform used is a website that contains information on design patterns, the information includes UML Diagrams to assist with the understanding of the patterns. Included with the platform is a section of the website that is to provide multiple choice testing for the design patterns, which includes a track record of scores in a statistics page which can be used by lecturers to see how their students are progressing.

## Aims and Objectives

The aim of the project is to create a case study based on investigating learning methodology using design patterns as a base, evaluating how the topic is taught and how it could be improved.

The objectives of the project are listed out in Appendix A, the Project Proposal. The core objectives remain the same being subjective to the changes in the final report, however remains to be relevant.

## Change Control

The project employs a basic form of change control, at regular stages of the production, the reports, research data and implementation of the product are all backed up onto an external source. These revisions of work can be accessed at a later date if required to view different changes to any parts of the uploaded work.

Sub Version Control Software was used to function as Change Control, uploading to a second source if anything happened to the first or second sources, copies can be easily made and work recovered from multiple stages.

## Overview

This report has 7 following core sections. The first section is a Literature Review that examines existing research into the field, bringing relevant research data to the project that is to be taken into account with the Requirements Analysis. The second section is a Review of other Learning Solutions, this section researches into two other implementations similar to the project, aimed to achieve the same goal. This provides further insight and data to put into the Requirements Analysis. The next section is the Requirements Analysis, bringing information from the previous two sections, it refines the data into a set of Functional and Non Functional requirements that were later justified in the design. The Design section applies the Requirements outlined in the previous section and brings them into a plan for implementation. This is a core step toward the development of the product, being an important bridge between the Research of Requirements and the Development of the product itself. The Development section returns back to the Design, illustrating any changes made after design with a justification of those changes made, along with implementation of the design. The section outlines any problems that occurred during the development of the product and how they were overcome. The Evaluation reviews the entire project overall, determining the success of the implementation and what future work can be done to progress the project. The final section is the conclusion of the report, providing a critical evaluation of the process toward the product, the product itself and the author.

# Literature Review

## Introduction

The purpose of the literature review was to look at work previously carried out in the areas of the project, looking at the ways other work has deployed learning systems in general and also how design patterns are taught. It looks at existing learning methods gathering both the advantages and disadvantages of existing systems. It looks toward learning methods of design patterns and investigates it's deployment toward the audience it is aimed at.

## Learning Methods

### Introduction

In the academic sector ways to be taught and learn information is an important topic to take into consideration. Students being taught in an environment, being a full university teaching students in a lecture or a website that teaches a student at home, the intended result is the same, for the student to come out of that session with new knowledge that they will retain. The way that the content to be learned being deployed for initial learning is an important factor, however this is not the end of the learning process, this content then has to be utilised at some point to be retained.

Different ways have been employed and full systems laid out to keep students with this knowledge, using sample implementations of the content to examine, texts and extra references, tasks and other such items would be used to keep the knowledge retained within the students. These methods are always being looked at and revised where necessary giving improvements to the systems in place. Typical systems have the same basic stages of learning, where information is provided then that information is required to be used in some implementation or tutorial afterward.

Poorly designed or implemented learning systems can have bad results, generally those that only use one method of teaching and do not offer any alternatives to cover extra ways to learn the content. Refining the learning process of any method of teaching is always important to the continued effectiveness of teaching content to the target audience.

### The Learning Pyramid

#### Introduction

The concept of knowledge retention and learning has been studied in depth for a long time. In the 1960s era the NTL Institute in Bethel, Maine utilised a concept called the Learning Pyramid(NTL Institute). This concept was developed on from an original Pyramid, called the Cone of Experience by Edgar Dale.(Audio-Visual Methods in Teaching, 1954). An adaptation of this created by the NTL Institute can be seen as Figure 1.

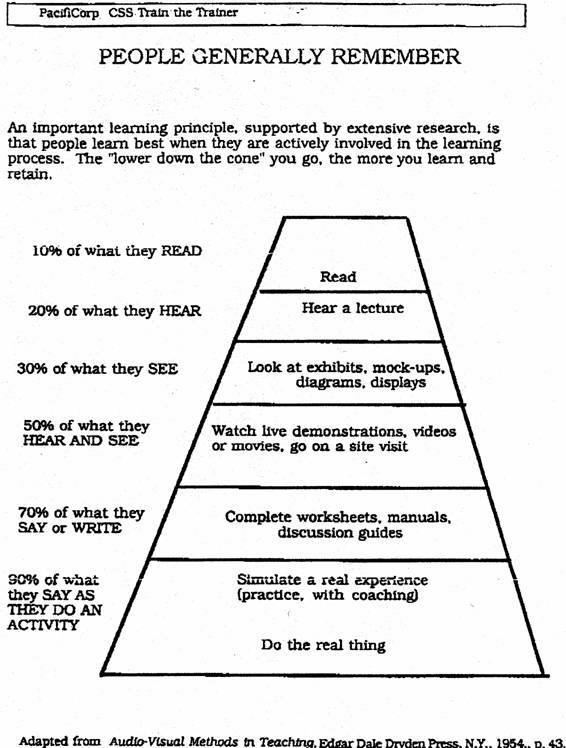


Figure 1

This is a core concept to be utilised when evaluating learning methods, this concept was taken from other studies conducted by the NTL Institute and has not been counteracted by any other concept to date. This concept therefore is an item that should be taken into consideration with any creation of learning systems or methods, as different methods of teaching hold different results. As seen in Figure 1, purely reading information holds far less retention in knowledge compared to people that practice implementations or utilise the knowledge in real implementations.

The actual numbers and figures of the extensive research that supports the Pyramid are missing and cannot be retrieved, yet NTL Institute believes it to be accurate. However, the actual figures and percentages differ slightly from different Learning Pyramids, the order remains the same and the figures are all similar. The percentages do not require a large degree of accuracy as the Pyramid is a broad account for knowledge retention with certain activities, rather than any specific account of any area of work. What remains important and taken from the Pyramid is the order and effectiveness methods have on learning, no other research or claims have discredited the order and rough percentages generated by the Pyramid and so still retains a high level of importance when used in evaluation of learning techniques.

#### Retention

Learning Pyramids describe the effectiveness of learning techniques as knowledge retention, with most of the figures remaining the same with different adaptations of the Pyramid, the core remains the same.

In approximation, students will retain a certain percentage of knowledge;

* 90% when used immediately or teaching another student.
* 75% when students practice.
* 50% when used in group discussions.
* 30% when in a demonstration.
* 20% when taught with an audio and visual component.
* 10% when reading.
* 5% when taught with a lecture.

The figures represent a ladder of increasing knowledge retention while being used in a different manner. The ways that the knowledge is taught is a key factor into knowledge retention, combinations of different variations of teaching produce the best results. Later more effective methods of learning as shown above cannot be reached without the less effective methods first, students will need to learn the knowledge beforehand via a lecture, reading or being shown before they can discuss the topic, practice and then teach. The most effective methods of knowledge retention is learning the knowledge via an initial method, then immediately utilise that knowledge with practice, discussion and even teaching to other students. Teaching between students and active use of the knowledge soon after gaining the knowledge allows for the practice of teaching, immediate use and practice, along with group discussions in one session.

#### Conclusion

Multiple sources yield the same information regarding the Learning Pyramid, the concept is familiar and is justified in other means. The Pyramid is a clear representation of studies put into the research of knowledge retention and learning techniques, often being referenced and used in other studies related to learning.

Use of the Pyramid is clear and it will be a core aspect used to evaluate methods of learning, comparing the aspects of each method to the Pyramid, gaining a view as to how effective the method is and what it uses to teach it's content. The insight to the effectiveness of each method is highly useful from the Pyramid and will be referenced to and compared with throughout this study.

### Repetitive Learning

Repetitive Learning is a method of knowledge retention often used in many aspects of teaching. The idea of repetitive learning is to repeat the same or similar tasks, usually via practice implementation from tutorials, tasks or tests to build up the retention of the knowledge. Research into this area shows that repetitive learning is a widely used technique and used across the board. For instance teaching a child to tie his shoe laces up is demonstrated by showing, but then doing. The first times that the child ties his shoe up would be performed in a poor manner, perhaps sometimes incorrect, however the repetitive requirement of the task, such as going out twice a day (thus required to have the laces tied twice a day) refines the task until the task is hardly ever failed. Repeating the task of having tied a shoe lace allowed the knowledge to retain with the child, after many repetitive ties of the lace it soon becomes natural to do.

The same can be applied with more academic learning, with tasks such as creating a UML diagram being repeated over the course of time. Initially a diagram might be of a bad design, have errors with its appearance or use, however over repetitive use of UML being created, the structure, design and appearance all improve, incorrect or bad use of sections of the diagram slowly fade out until the task becomes easier and requires less effort.

The act of repeating a task will imprint it into memory, being a core method of knowledge retention. Most tasks carried out are learned and refined from repetitive use, this case study evaluates the use of repetitive learning and holds results to either support or counter its use. This method of learning utilises practicing the knowledge, as seen in Figure 1 before is a good way of retaining knowledge.

### Testing

The use of tests is a method of knowledge retention that is also found in common use. The tests provide an active requirement for the knowledge to be put in effect, often weighting progress based on the results of the test. This provides an active motivation to the test, often implementing other ways of learning beforehand.

Testing can be used for learning more than just an evaluation of a particular student, testing provides a clear result and mark of a student's knowledge, providing feedback quickly on a particular test and indicates areas that require improvement. Multiple tests also provide positive feedback and motivation to the student, as the student can see improvement over an amount of tests what sections have improved and what need to be worked on, this relates back to repetitive learning. An example of this is past exam papers, these papers are similar to what the exam contents hold, often on the same topics across all of them. These past paper exams can be taken by the student, the results then can be viewed by the student, seeing what parts of the test they need to learn more on, often with the answers included to demonstrate why or how the student was wrong and the difference between their answer and the correct one. These taken multiple times can see an active path of improvement and knowledge gained from seeing a corrected answer from a previous test and has an immediate use for the knowledge by taking the next test. This relates back to the Pyramid from Figure 1 and also section 2.2.3 using immediate practice and repetitive learning for knowledge retention.

### The Human Factor

The human factor in learning is an item that needs to be taken into consideration when viewing statistics of learning success rates. Each student who comes to learn a particular subject will be different, generally employed methods may work for most students however there are going to be a number of students that do not fall into the general bracket. These students require alternative methods to learn and retain knowledge easily.

A commonly used model for ways that students learn is Fleming's VARK Model (Neil Fleming, 1987) that describes three main ways of learning;

* Visual learners
* Auditory Learners
* Kinaesthetic Learners

Visual learners make the best out of seeing content such as pictures or diagrams, later retaining the knowledge for further use. Auditory learners make the best out of listening to discussions such as from a lecture or other learners. Kinaesthetic learners make the best out of firsthand experience by performing the action themselves.

While general methods cover most people and teaching styles that are not the most effective for some students, knowledge is still retained but at a lower rate.

### Conclusion

Learning methods is a core focus of this study, results produced in this study will either support or counter against learning methods that are in use, determining the effectiveness of certain aspects of learning and evaluating them. The Learning Pyramid from section 2.2.2 is an important item for consideration in any surveys, questions or interviews in this case study, it will influence the content of each to conform with the model outlined in the Pyramid.

While there are some methods of learning that are clearly better than others, there is no clear cut method of learning that serves all, the Human Factor being a large variable in the effectiveness of methods being effective, combining multiple methods of learning provides the best results for knowledge retention. The review of knowledge retention demonstrates a clear scale of the effectiveness on different methods of teaching, the implementation targets these areas of high effectiveness and this is also taken into consideration with the Requirements Analysis.

## Design Patterns

### Introduction

### The different design patterns

### Use of design patterns and their benefit

## Legal Social Ethical and Professional Issues and Considerations

The product is aimed at students to take, using tests on the product implementation to create a collection of results for analysis in the case study. The data produced by the students as well as students being the target audience has to be taken into consideration with both Legal and Ethical views.

Ethically, the students are aware that results are being taken. With relation to the Data Protection Act, no personal details are asked for with surveys and any results taken from any source in the study will not contain any personal data, only statistics on the choices. For the purpose of statistics generated in this study, there is no requirement to use anything more detailed than the name of the student.

Any students that use the implementation or provide any data are made fully aware of what the data will be used for, all information that is forwarded into the study is notified with the student prior.

A standard consideration is taken into account with Copyright Infringement and Plagiarism. The product implementation is copyrighted to the author with all rights held from the date of creation.

## Key issues to use in the design and implementation

## Conclusion

# Review of Other Learning Solutions

## Introduction

The case study includes a review of other Learning Solutions that exist, comparing key factors in each solution, advantages and disadvantages of the implementation of other solutions. A review of other solutions provides insight toward other attempts at high knowledge retention systems including their appearance, usability and effectiveness. This demonstration provides a preview of the effectiveness on the implementation from this study before testing.

## Codecademy

### Overview

Codecademy is a website that is free to use, aimed as an easy way to learn programming. Codecademy claims that "Codecademy is the easiest way to learn how to code. It's interactive, fun, and you can do it with your friends." and leans on to demonstrate some of the features. It lists that the programming knowledge gained from the site can be used to create websites, games and other applications in a broad scope, the ability to learn with friends and to view a progression system.

### Appearance

The website has a clean appearance, the layout is well defined with a contrasting colour scheme. There are no parts of the website that have similar colours or are hard to see. A simple navigation bar at the top of the website can be seen from Figure 2. The purpose of the website is clear on the right hand side of the website, Get Started provides a clear instruction to use the dialog box on the left side of the website to continue. The instructions in the box are clear and puts you straight into the basics of programming, giving you feedback on everything you do if negative or positive. Entering in the wrong commands gives you an error along with a hint on how to complete the task. The final section of the website shows off some of the reasons to use the website, demonstrating the progress tracking with an example screenshot. Going further into the website tracking is made clear and the overall feel runs smooth, there are no sections that are not self explanatory providing for a good usability.

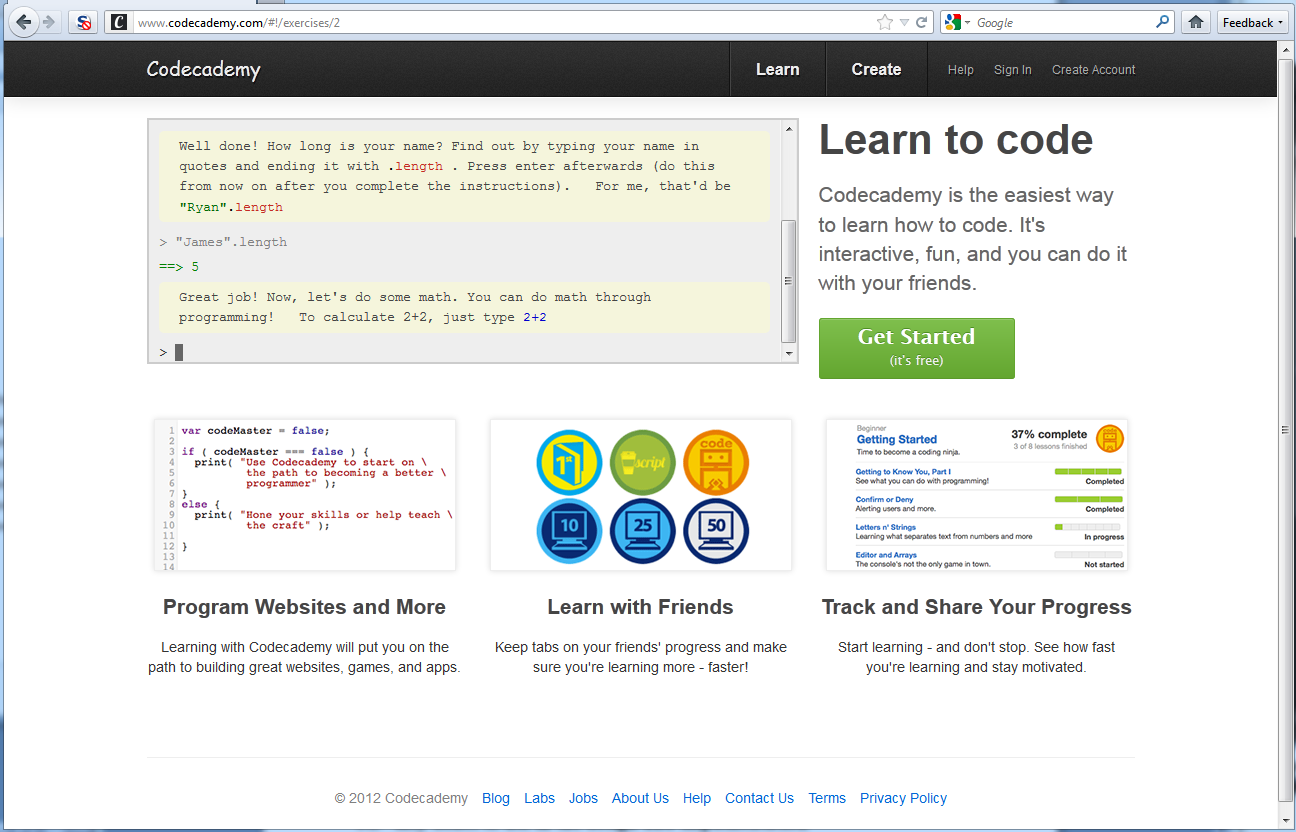


Figure 2

### Usability

The usability of the website is high, items on the front page are clear and self explanatory, the website has a clear login system which brings you straight back to your previous level of work. The console box that is used to teach the programming knowledge is easy to understand and self explanatory to a high detail, even such as telling the user to press enter to enter the code into the console. Any input made by the user has clear feedback related to 3.2.2, the appearance of the box, describing any actions that need to be taken to either fix the mistake that was made or feedback on correct input are long enough to explain the working of the code but not too complex that starts to confuse users.

After the first section, sections are skip able if the user decides to do so, while the user can also return back to previous sections to revise code already done. Each section provides a short description of the topic and why the topic is useful for programming, such as describing the use of variables. The description also integrates with practical involvement on how the variables are used, tasking the user to put them into the console and utilised the knowledge instantly gained. This relates back to Figure 1, the Learning Pyramid of instantly applying knowledge in a practical manner for maximum retention.

There is another section attached to the learning called a Scratch Pad, this is an integrated basic development console that enables the user to utilise their gained knowledge in any manner they like with a free form console to test the programming language they are learning. This lets users test out various ways of using their knowledge and expands the set of available tools at the users' disposal to do a practical implementation.

An overall section shows easy and clear statistics providing instant feedback and progression data to the user. Achievements are shown on the page as a clear marker for what the user has achieved and learned with the website. A total progression figure is provided in this section, after reaching 100% it unlocks another achievement.

### Summary

Codecademy is an implementation of a learning technique targeted for easy learning with high levels of retention for knowledge. It uses short and clear texts for background information while maintaining high relevancy of the actual subject, the user can see the results of their work instantly after submitting it with information feedback on the results. The website employs immediate practice of the subject while being taught which as seen from section 2.2.2, is a very effective method of knowledge retention. The website has positive feedback as a good way to learn programming from a beginners point of view, allowing to teach from the basics to more in depth topics.

Overall the website is a good method of learning, the way it teaches programming is not entirely unique to programming languages but can be used in other areas where immediate practice produces instant results, having clear feedback on any actions taken along with positive reinforcement techniques and easy progress tracking.

## ProProfs Quiz Maker

### Overview

ProProfs Quiz Maker is a free to sign up website that contains a large database of tests which anyone can take. The tests are user generated and can be taken by a user that is not registered to the website, but can still achieve a mark out of it. The website's front page advertises the features of the website, describing the detail the tests go into and its ease of use. Users viewing the front page of the website are also attracted with quotes from various people, and a list of organisations that the website is trusted by.

### Appearance

On the front page the website has a lot of pictures and text to view at once, large bold text with pictures accompanying distract the user to view certain aspects of the page first, highlighting the positive aspects of the website. The lower sections of the website initially has a section containing top user quotes, from people who have used the product and returned a short review. This also contains a section showing organisations that have trusted the website, the initial appearance attracts the user and highlights as to why the user should use the website as opposed to similar websites, see Figure 3.

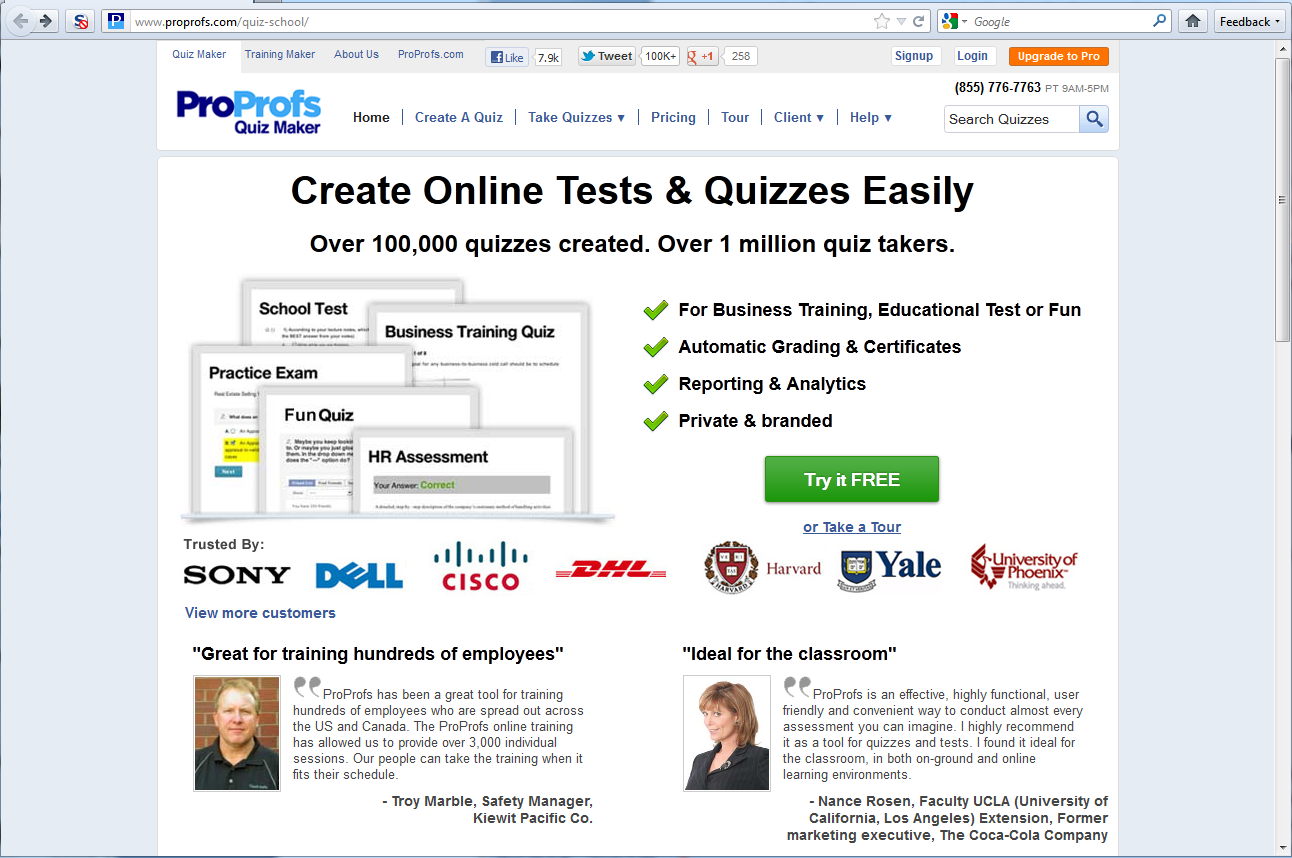


Figure 3

Further down the page the website gets less attractive and more informational based as it describes the more technical aspects of the website. The rest of the website remains clear and easy to read, there are no sections that have clutter or hard to read texts.

### Usability

The website appears to be complicated at a first glance, the first page contains a lot of information, however passing the first page it allows the user to go straight into registering an account to the website to start creating tests, or taking a tour of the website to demonstrate it's set of features and usability. Linking directly to a test will bring a user to a test page, this page is configurable by the creator but typically lays out a description of the test and displays the questions. Starting the test is a one button click, not requiring a login even guests can try the test. Going through the test provides instant feedback telling the user if the question just submitted was correct or incorrect, this feedback also does not affect the results of the forthcoming questions in the test. Once completing the test the user is presented with an option to login to attach the test to their statistics page if they are not already logged in, if the user is logged in they automatically get presented with their statistics page and results of the test just taken. The page a guest views is similar to a page used with an account, however it does not persist and is lost after the user navigates away from the page, aside from a small generated image that contains the score of the test. The interface is smooth, fast running and presents a clean way of taking a test on a website, all the buttons and functions are self explanatory.

### Summary

ProProfs Quiz Maker is a website that contains the ability to make and take tests, a simple concept that yields high results. As taken from Section 2.2.2, the website uses immediate feedback for each response taken, knowledge learned from any source can immediately be put to the test without a requirement to be logged into the website. The website can be linked and integrated into other websites to join learning material with the test afterward, this moves into immediate use of knowledge and gathers a high retention rate, using feedback and award systems, statistic tracking and other records to provide a stable system for learning.

A small issue that the website has no review of user tests, so tests have no backing as to their validity in the field, however tests can be created by academic figures and specifically linked to students, these tests can be checked internally and used within the academic system, allowing the website to remain as a learning platform with valid information. Owners of the test can view statistics of all the users that have taken their test, showing their own individual statistics and general statistics of the test.

## Key issues to use in the design and implementation

Codecademy provides an easy to use implementation with a clear and easy to use design. From examining the website in detail a few issues to bring into the design and implementation are brought up. A clear easy to use interface is important in the design and implementation of the product, allowing the user to easily access information and use the functionality of the implementation. The website provides positive reinforcement from the use of progress bars and achievements, the use of positive reinforcement is something that should be taken into consideration. Codecademy also uses immediate use of knowledge in the form of small testing and tasks, repetitive use of skills learned during the teaching and no large gaps between teaching and implementation. The website has a lot of positive reviews so its techniques are to be taken into consideration with the design and implementation of the product from this study.

ProProfs Quiz Maker provides a simple and easy to use implementation of a test service, that can be used for practice or recorded test statistics. Examining the website in detail brings a few key issues to bring into the design and implementation phases of this project. As seen with Codecademy, a clear and clean interface is an important part of the website and will be taken as a key issue from this section. The website also provides positive reinforcement with the use of achievements, certificates and statistics, another item that matches with Codecademy. Tests can be taken repeatedly, each test showing the correct and incorrect answers, and what the incorrect answers should be allowing the user to learn from the test more easily. The large amount of reviews from high level academics, and endorsements from other well known organisations makes the website highly reputable.

A short list of points to take away into design and implementation;

* Clear and easy to use interface
* Statistics and progress display
* Allowing repetitive use of the website's features
* Feedback display to allow further learning

## Conclusions

After examining both websites in detail Section 3.4 details a small number of important and successful techniques that should be used in the design and implementation of the project. A review of other products has given a strong insight into how successful implementations can be created, providing items that should be taken into consideration with the design and implementation of the project's implementation. These points are taken directly into Section 4, Requirements Analysis, and considered important to the success of the implementation.

# Requirements Analysis

## Introduction

Before any design and implementation can be produced, a requirements analysis was created. The requirements analysis contains Functional and Non Functional requirements created from the Literature Review and Review of other Learning Solutions (Section 2 and Section 3).

## Implementation

The implementation of the product was determined from the research in Sections 2 and 3, the Literature Review and Review of other Learning Solutions. Based off those sections the product implementation was decided to be a website that had sources and content based on design patterns, and a second part of the website that was a test system to deploy that knowledge into instant practice and feedback. The product is to be used as a website rather than a standalone program to allow for easy of accessibility and compatibility. A website does not need to be ran or downloaded as an executable file, and can be accessed almost anywhere with an internet connection, or run locally on an intranet service where internet is not available.

The target audience for this product was aimed at University students studying software engineering, but also covers a larger scope of anyone that has interest in design patterns or trying new ways of learning and retaining information.

## Functional Specifications

### The Website must allow the user to take tests

The Website is required to allow the user to take a test to put the knowledge into immediate use. This is an important part of the website to allow for evaluation of multiple tests to increase knowledge retention.

### The Website must show statistics from previous tests

The Website is required to allow the user to view their statistics from previous tests. This is to allow the user to view their track record and see their improvement in a quantifiable figure.

### The Website must show correct and incorrect answers

The Website is required to have the ability to show correct and incorrect answers to allow the user to view their mistakes with each test, and be able to correct them by viewing the correct answers and if need be conduct further learning before taking the next test.

## Non Functional Requirements

### The interface appearance shall be clear attractive

The appearance of the product shall be clear, easy to use while retaining functionality. Use of a Cascading Style Sheet in the product will allow for the standard to be maintained and appearance to be clear and easy to use.

### The website shall be easily usable

The website shall be easy to use and understand, the access of each part of the website should be free and little to no understanding required to use the website.

## Legal Social Ethical and Professional Issues and Considerations

The target audience had to be taken into consideration with this product, the main target is University students in the field, however the scope can contain a broader use of the product and is not limited to just University students. No extra research is required with the aimed target audience as it is covered by the University itself.

## Summary

The requirements analysis gave a detailed view of what is required for the product implementation, focusing in some areas of the implementation to provide a product on standard to achieve the goal outlined earlier, to demonstrate the use of learning methods and their effectiveness.

# Design of the Website

## Introduction

The design of the Website is a large step toward the actual implementation of the website, a critical step between research and implementation, the design lays out a structure of the website and the core foundations, however during development the design will be improved on during regular stages of the development. During these regular checks of the design against the development, any design choices made can be changed if required to further accommodate the requirements outlined in the previous section.

This design section outlines three main stages of the design, visual, technical and content stages with how they came into effect, and the reasons these design choices were made.

## Visual Design

The website is designed to be clear and easy to use, visually the effects are simple and clear without any complex or difficult to read regions of the website. Three main regions are in the website design, the top region is the title of the page, along with it is a login system that remains on the website at all times. After a user has logged in the login dialogue changes into a small area that greets the user by name, easily identifying the account in use of the page, along with an option to logout of that account.

The next section is a small bar that is between the top and content sections of the website, containing links to the various pages of the website, this also persists with the top bar to allow for easy navigation and access throughout the website.

The last main section is the content area, that changes dependant on the page the user is on. This should be in a clear and easy to read layout.

The use of CSS on the website is to achieve the requirements listed in Section 4, and to achieve the visual design. CSS allows management for appearance of the website, allowing more functionality for appearance styling than a default website page using HTML.

## Technical Design

To achieve the visual design outlined in Section 5.2, PHP is a selected language for the technical aspects of the website with coordination of the CSS. Via the use of extra pages loaded on every core page, aspects such as the permanent top and navigation regions of the website is possible.

A header is loaded with each page of the website which generates the first two regions of the website, this header page also generates the address bar and the client code for the login system.

A foot page is loaded also with each page to finished the main page of the website, closing off some variables that are left open from the header page and bring the lower end of the website to a clean end. The foot page can also be used like the header to provide persistent items at the bottom of the website.

A utility page is also created with the use of PHP, this page has no appearance or styling in it but contains essential workings of almost every page of the website such as connection creation to the database or creation of the session system employed on the website. The sessions will be used in the website to carry data across and also used for the login system. Session data will also be used for other workings of the website such as the testing, where the data is collected in the session before submitted to the database.

The database will be a MySQL database, designed to hold any information the website requires to use as persistent storage. Session data from the website only works for as long as the user is logged into the website and is not usable for any persistent storage, the session data will be limited to the website interaction with its own pages only. The database will store accounts, tests and test statistic data in separate tables so that the website can input and pull this data when it requests the use of accounts, tests or the statistics of the tests in different sections and functions of the website. The nature of this also allows for the database to be in a different physical location to the website if needed, however this will have a negative effect on performance as the performance is highest when both the database and web server are together on the same box, creating the least delay for SQL functions to be used.

During the later phase of the design, the database was determined to be inefficient and of a poor design, a second ERD was created (Appendix ) to replace the initial ERD. This newer database was more efficient and cleaner than the first. The new database was designed to work by joining other database tables together in SQL queries to bring a full set of data required with far less unneeded information, bringing a more efficient query each time it was processed.

## Legal Social Ethical and Professional Issues and Considerations

The website design remains close to what was brought from the Requirements Analysis, the design does not include any mechanisms that breach Ethical issues, all stat tracking is clearly marked and accessible by the user, there are no hidden data storage systems for hidden statistics made only available to the website manager. Everything in the MySQL database is brought from the website, users cannot see other data from other users, the database does not contain sensitive personal information of the users of the website.

The website remains a target for student use at the University, not targeting children or any underage individuals, the project remains to be focused on adult students that are taking part of a University Degree.

## Justification of Design

The use of the design is justified by the research taken in the Literature Review and key points taken from the Review of other Learning Solutions.

The Visual Design uses Cascading Style Sheets to process the appearance of the website, majority of websites with good visual appearances use CSS to manage and display the appearance of the website pages, unless the entire page was created using JavaScript, Flash or other similar languages that overwrite the normal appearance. A clear and easy to use interface came from both the Literature Review and Review of other Learning Solutions. The key points taken from both sections reinforced the requirement for a clear and easy to use interface, which was incorporated into the design of the website.

The Technical Design uses PHP to use the server side code. PHP is an easy to use, easy to learn language that allows for high functionality of server side code for the web pages, integrating well with HTML, the core foundation of the website. PHP contains all the functionality required for the website, including interaction with the database, capable of handling all the design placed onto it. PHP is easy to use and a more complex server side language is not required.

The database uses the MySQL database in the design, this database is open source, allowing it to be used without any extra costs to the creation of the website. This free database system is also a "high performance, high reliability" service , providing all the power required for the website and all the functionality. MySQL also works well with PHP, a design choice for the server side working of the website.

The design focused around a multiple choice test system, this test was designed to be repeatable and provide instant feedback to the user, going back to the Literature Review, instant use of knowledge, providing feedback and the allowance for repetitive practice provide higher results in knowledge retention.

## Summary

The design covered all aspects required on the website, the core aspects were highlighted and planned with the design, relating back heavily to the research sections 2 and 3. The design was solid from the start of development, however it was also left open to changes during development to refine the product, this later turned out to be used with the database implementation and other smaller changes to the website.

# Development of the Website

## Introduction

The implementation of the website was the final step on creating a functional website. This came into place from the core foundations set out in the design phase of the project. The final implementation is a sum of all the design and research that was created up to the start of the implementation, building up to a product that meets the initial aim of the project.

This section discusses various parts of the implementation, technical issues and testing conducted.

## Implementation

The website was implemented and did not change largely from the design, a few items were modified from the design stage of the website, others were build upon the design of the website to enhance the final product.

The initial phase of implementation began with working on the back end of the website, starting with the three main PHP pages that would be used with all (aside from back end functionality) pages on the website. The utility page was created first, this page is imported into every other main page of the website and also joins in with back end functionality pages, with final implementation the page processed the connection to the database and started the session, which enabled the use of database connectivity and session variables throughout the website. A header page was created after to serve as the top section of the website, this header contained content that was displayed continuously through the website. The header contains the website title, the login system and the hyperlink bar. Initially these were just implemented for functionality, however the next phase moved onto the visual design of the website. CSS was then used to start the visual implementation of the website, CSS rule sets were created and used for the header, including the rule set for the hyperlink bar, login box and the title.



Figure 5

Figure 5 shows the results of the header, returning back to Figure 4 showing the initial design, the final result for the header turned out very close to the design, using a slightly different colour to illustrate the link bar, the title and login sections were both placed and fit in the same position as the design. The use of CSS was essential to the end result.

The foot section closed off any open variables left from the header, such as the HTML tags and also provided a small block of information enlisting the current time, and the copyright notice. See Figure 6.

http://puu.sh/rAn9

Figure 6

The content page was different for each part of the website, however these pages always included the header, foot, and utility pages mentioned previously. Pages such as the statistics page used a database query, then this query was processed in a loop that populated the page for each result returned by the query. The following cut-out of code shows an SQL query for the statistics page.

"$result = mysql\_query("select examsession.id, examsession.time, exam.title from examsession inner join exam on exam.id = examsession.examid and examsession.userid = $uid order by time desc limit 11");"

This query is limited to produce 11 results, this prevents the page overpopulating and escaping the limits set out by the page. This result is then put into a loop, for all of the results returned it adds in a new line entitling the title and total score, a new line with the data the test was taken and a final line with a link to the more detailed page for that test. This generates the final result on the page, this can be viewed with Figure 7.

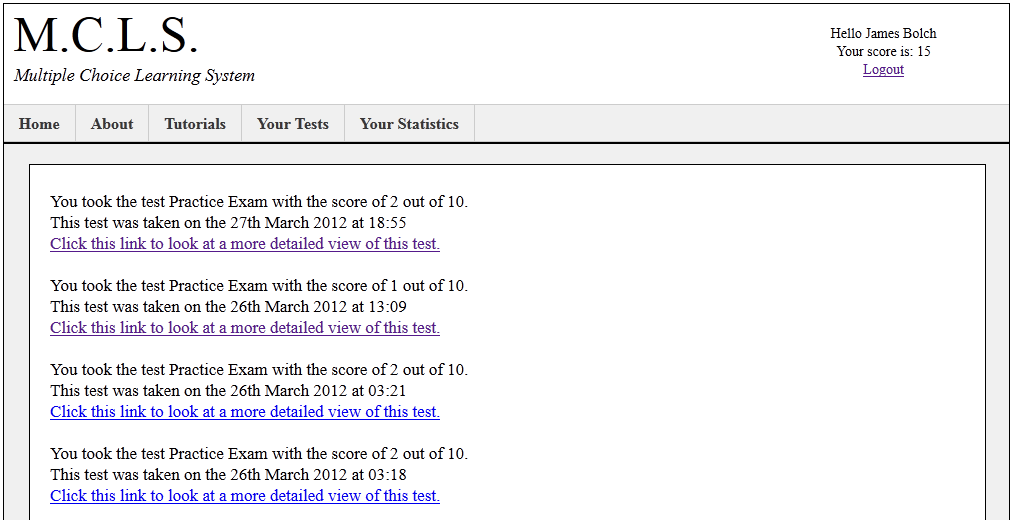


Figure 7

Other pages were similar in function, either pulling or placing data into the SQL database, aside from a couple of pages that had no server functions other than informational pages.

## Technical Problems

PHP was a new language to the author, some technical problems along the way were mostly due to the lack of knowledge on PHP as a whole. These problems were quickly fixed by examining tutorials or information provided for the PHP Language.

PHP and MySQL connection was easy to establish, however there were some difficulty transforming session data to SQL Data. This was quickly rectified with some small documentation assistance and a few incorrect attempts at transforming the other data.

The CSS implementation of the link bar had some technical difficulties to provide the correct look, getting the bar to change into horizontal buttons as opposed to vertical plaintext links was the final goal. This was achieved using some documentation provided with CSS, to establish the properties required in the rule set inside the CSS file to achieve the goal.

The rest of the implementation went well and provided very little technical difficulties.

## Testing

Active testing was done during the development of the website, changes were made to the design and later followed on into the development. Testing of the database provided that it was quickly becoming a problem, shunting unneeded data into the website and was more difficult to pull the correct results. A redesign of the database commenced after this testing and the new implementation persisted to the final product. This implementation of the database used joins to bring more data to the website if it was required, rather than forcing it to bring the extra data each time.

Extra testing during development involved attempts at breaking the database through he use of the website, by inputting invalid data or SQL injection, however using escape strings, SQL injection was impossible and invalid data did not cause any unexpected issues.

## Summary

# Evaluation

## Introduction

## Implementation

## Technical Problems

## Final Testing

Final testing brought out a few issues with the website.

Testing of the website yielded the problem of a slightly difficult task of navigation from the start page after logging into the website. Feedback gained from testing from external sources determined that the link titled 'Your Tests' was not clear as to its function, this lead to slight confusion as to what needed to be done after logging in. The original determination of the button was to demonstrate a list of tests available to the user that can be taken, entitled as tests direct to the user itself. A small caption directing the user to the navigation bar exists after logging in, but does not direct them to any specific area of the website. This problem could be easily fixed by adding a small section directing the user to the correct button, or renaming the button to a clearer name such as 'Take a Test'.

User testing also determined that exiting a page mid test or attempting to go back to another page yielded strange results. While a small warning occurred, this could be ignored and going back a page will restart the entire test itself, the existing progress of the test is still saved however, bringing strange results into the database and statistics page. This behaviour could result into a sliced test, where half the statistics are saved for one test and the website counts the second have as a separate test. This was an unforeseen error and would require far more work to bring in error recovery and management, forcing the user to stay on the page or recovery of previous location in the test. A shorter temporary system is easy to implement of simply terminating the test if incomplete and not marking it toward the user.

Testing also provided the feedback granted from a user, this user mentioned the lack of progress inside the test. During a test there is no progression bar and no way to tell how far the user is inside the test, this is a small item to fix that is rectified by a small progress bar on the page, displaying the current question number with the total number of questions for that particular test.

One last item picked up from user testing was a lack of feedback from the login system for any failed logins, it did not specify if the login failed due to an incorrect username of password. A small extra page or modification to the login section returning the specific error can be used to fix this and return more specific feedback rather than the general feedback it has.

## Summary

# Conclusion

Bibliography

# Bibliography

Codecademy. (2012). Retrieved March 2012, from Codecademy: http://www.codecademy.com

MySQL. (2012). Retrieved March 2012, from MySQL: http://www.mysql.com/

ProProfs. (2012). *Quiz Maker*. Retrieved March 2012, from ProProfs: http://www.proprofs.com/quiz-school/

1. Project Proposal
2. Gantt Chart