Creating an Interactive Learning Resource for Teaching Scratch using the Kinect for Students
Throughout Key Stages 2 – 4
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Summary

Scratch is a free educational programming language which has been designed to be easy to learn, educational and fun. Scratch allows users to program by dragging coded blocks from the block palette and attaching them to other blocks to create scripts. It allows users to understand the underlying principles of programming and create unique interactive stories, games and animations. This project looks at how Scratch can be used to teach students programming by creating games, detecting errors and using the Kinect to control games. The project was created in response to the amended ICT National Curriculum being implemented in September 2014 and in response to local request to the School of Computing at the University of Leeds from both primary and secondary school teachers. The project identifies the changes to the National Curriculum and assesses existing online learning resources currently used by teachers and students. The findings were used to create an online learning resource which achieved targets outline in the new Computing National Curriculum. The online learning resource consists of activities for students within Key Stage 2 – 4, which incorporates the use of Scratch and the Kinect. The online learning resource was continuously evaluated by both teachers and students to ensure that a successful resource was created. As a result of continuous evaluation and recommendations from teachers and students a successful online learning resource was created and the resource is planned to be available on the STEM website as a self contained online learning resource accessible via www.stem.leeds.ac.uk in the future.
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Chapter 1

Introduction

1.1 Aim

The aim of this project was to deliver, with the help of Scratch, an online learning resource which teachers and students can use at school and at home to enhance and develop their understanding of programming. The learning resource consists of several lessons, containing a number of different steps for the students to complete throughout Key Stages 2 – 4. Several steps within the learning resource have the option to download snippets of Scratch code, which the students can use to complete the task at hand. Once the students have developed an understanding of Scratch, they will then develop their games by incorporating the use of the Kinect to make programming interactive. The learning resource aims to help teachers to deliver the new computing curriculum where programming has become more prominent. With the resource being available online, the students will be able to work through the variety of tasks at their own pace whilst at school, and continue at home.

1.2 Objectives

The main objectives identified at the outset of the project were:

- To conduct research into the National Curriculum to understand why the ICT curriculum had been changed and what the differences were between the old and new curriculum.

- To produce a Scratch teaching resource which allowed teachers to educate students on the basic concepts of programming, such as ‘IF’ statements and ‘FOR’ loops.
• To create an online learning resource which contained tutorials that students could complete whilst at school and at home.

• To ensure that the final online learning resource could be used by Key Stages 2 – 4 students and teachers for future academic years.

• To ensure that teachers and students were actively involved throughout the project to gain recommendations for improvements during implementation.

• To evaluate the online learning resource, using both teachers and students.

1.3 Minimum Requirements

In addition to the objectives specified above, the following minimum requirements were constructed after an initial discussion with the project supervisor:

• To identify existing online learning resources and evaluate them accordingly.

• To create an online learning resource which contained prepared lessons which students could work through at their own pace.

• To create a resource with a minimum of 5 lessons per Key Stage, which included an objective and an overall final result for each lesson.

• To create lessons which expand on prior lessons and allow the students to enhance their understanding of both Scratch and the Kinect.

• To allow students to download example programs and snippets of Scratch code that they could amend. Therefore allowing them to add to and modify the project, without having to re-create the main script again.

1.3.1 Possible further enhancements

• The learning resource could have a submission page which would allow students to email their teachers the Key Stage, lesson and steps they have completed that lesson at school and attach their completed programs.

1.4 Project Planning and Methodology

1.4.1 Planning

The project began with a period of background reading and research. This explored the current ICT curriculum and the difference between the existing and new computing curriculum. It also investigated
and evaluated a combination of existing online learning resources for children from Key Stage 2 to 4. The background reading provided a thorough understanding of the problems of web accessibility and how to construct an online learning resource using different web resource tools. A user study was conducted which highlighted the strengths and weaknesses of a current online learning resource. These findings were used to design and prototype the projects website. During the design phase learning objectives from the new national curriculum for computing were identified as key learning objectives which were addressed through various steps within the online learning resource. This was then followed by the development of the online resource over three iterations. After each iteration the website was evaluated by both teachers and students to continuously improve the resource. After the third iteration a final evaluation took place with teachers and students to evaluate its effectiveness for addressing the learning objectives identified in the design phase.

1.4.2 Methodology

The project was a learning resource development project and therefore did not fit neatly into a standard software development framework such as Rational Unified Process, Agile Unified Process or a Waterfall approach. The project therefore took a route of rapid prototyping, once existing online learning resources had been evaluated and design ideas had been created. Each prototype was designed, created, implemented and then evaluated after each iteration to ensure that the project created a successful learning resource. Rapid prototyping was chosen as the methodology as the risk of the requirements changing was quite high. Rapid prototyping allowed requirements to change with minimal disruption to the final resource. The project aimed to produce a unique online learning resource to meet the proposed objectives and bring about beneficial change for teaching computing at schools. The lessons created on the website addressed key targets for each Key Stage of the National Curriculum.

The milestones allowed the project to be reviewed by teachers continuously which, ensured that the operational requirements for the online learning resource were being met [16]. The project constantly evolved, and the tasks changed during each iteration. The project required several iterations in order to create the best possible learning resource, which teachers and students would find useful and use in the future.

1.5 Evaluation Methods

In order to assess whether the project’s objectives were fulfilled, the following approaches were agreed as effective ways of evaluating the project:

- Student Evaluation – Recruit students to complete lessons within the online learning resource and issue a questionnaire which evaluates their experience of the learning resource. The questionnaire asked the students to rate the usability of the resource, whether they found it enjoyable
to use and whether they learnt anything from the resource. The time taken to complete each step was recorded to ensure that the lessons fulfill a 50 minute time period.

- **Teacher Evaluation** – Recruit teachers from both primary and secondary schools to evaluate the online learning resource’s design, functionality and assessment criteria.

- **Website Evaluation** – Ensuring that the online learning resource conforms to all HTML5 standards by using [www.validator.w3.org/](http://www.validator.w3.org/). This will ensure that it is compatible across all browsers.

- **Project Evaluation** – Evaluate the project by identifying whether the project objectives and minimum requirements were met or exceeded.

### 1.6 Project Deliverables

Figure 1.1 shows a Gantt chart which was created at the start of the project to identify each milestone and task. Each milestone and task was assigned a completion date, in order for the project to be completed on time.
1.7 Project Schedule

1.7.1 Original Schedule

In addition to the tasks identified in Figure 1.1, a number of milestones were created. The initial milestones chosen were:

- Finalise project aim and objectives: Week 5
- Completion of the background reading: Week 6
- Formulation of initial website: Week 11
- Evaluation of the website: Week 11 - 15
- Completion of the final evaluation: Week 15
- Final submission of the project: Week 16

Figure 1.1: Initial Project Schedule.
Figure 1.2 is a revised schedule for the project. The original schedule was revised as the completion of the background reading was extended from week 6 until week 8 to give time for the targets of the new computing curriculum to be analysed and organised into achievable targets for the lessons. These targets needed to be broken down into lesson objectives, which could be used to build tasks for the students in order for them to achieve the desired target set in the new computing curriculum. The user study was started and completed as planned which allowed for the design phase to commence as intended. The implementation phase was started as planned and was completed two weeks earlier than the original schedule, by the end of week 13. This was due to the local teachers not responding to emails and it was therefore decided that the website needed to be completed as soon as possible so that there was extra time available for testing the resource.
Chapter 2

Background

The aim of the background reading was to research the new national curriculum, why the changes have been made and identify the strengths and weaknesses of existing online learning resources in order to create a successful online learning resource.

2.1 Introduction

In 2013, Michael Gove, secretary of state for Education, announced the scrapping of the existing ICT curriculum, to make way for a new course of study in computer science which will come into play for teachers in September 2014 [11]. Currently the ICT National Curriculum is outdated and students find it extremely boring learning about Microsoft Word and Microsoft Excel, and therefore eliminate it from consideration for further study [8], [11]. This is shown in evidence from The Council of Professors and Heads of Computing (CPHC), which reported that there has been a decline in pupils taking A-level Computing and applying to study Computing, Information Technology or Computer Science at University [42]. Not only do students find the curriculum boring but so do teachers and the new course of study in computing aims to change this. This move has been supported by industry experts including Ian Livingstone, co-founder of Games Workshop, the British Computing Society and ICT professional association, Naace. This change in the National Curriculum has encouraged companies such as Microsoft and Google and Cambridge University to start work on providing free materials for schools so that teachers are more prepared [12]. The new curriculum gives schools the chance to review and enhance their current approaches in order to provide an even more exciting and rigorous curriculum that addresses the challenges and opportunities offered by the technologically rich world in which we live in. In his speech made at the BETT Show in 2012, Gove demonstrated that the
education system in the UK has barely changed over the centuries with the current ICT curriculum neglecting the computer science and programming skills required for high-tech industries. The ICT curriculum does not prepare the students to work at the very forefront of the ever changing world of technology and therefore allows students to leave school with not even the basic skills needed for a respectable job [11]. Michael Gove’s opinion is supported by Ian Livingstone, who in 2011 Next Gen report [27] stated that students are not provided with skills that are required for a future in technological industries such as video games and visual effects.

2.2 Educating Students Using Technology

During the BETT show for technology, Michael Gove asked the question, “What can technology do for learning?” and gave three key points in answer. “Firstly, technology has the potential to disseminate learning much more widely than before. Subjects, classes and concepts that were previously limited to a privileged few are now freely available to any child or adult with an internet connection, all over the world” [11]. The World Wide Web allows teachers and students to access any online learning resource, therefore providing them with an ever increasing library of teaching and learning material. However as online materials expand and increase in number, it needs to be taken into consideration, that teachers and students can become overwhelmed and therefore need to be guided through the information in order to benefit from the learning material [11].

The second key point made was “Just as technology raises profound questions about how we learn, it also prompts us to think about how we teach” [11]. Looking at how students learn and how the curriculum is taught can dramatically impact a student’s understanding of the curriculum. Students are being taught in various different ways across the UK, which is dependent on the students school or teacher. There are many online learning resources which are available already to teachers and students, such as o2 learn. o2 learn is an online library of lesson videos created and uploaded by teachers to be used during revision and lessons [38]. Another success in online learning resources is iTunes U, where lectures from the world’s top universities are available to any teacher or student all over the world. Finally another successful online learning resource is Khan Academy, which is used by more than 3.5 million students every month, and is currently available in 10 different languages [11]. All of these resources show that students are being taught very differently all over the world and teachers are continuously thinking of new ideas to make learning more interesting.

The third key point made was “Technology brings unprecedented opportunities for assessment. Teachers can now support pupils’ learning by assessing their progress in a much more sophisticated way, and sharing assessments with pupils and parents” [11]. Online learning resources allows students to work through the lessons at their own pace and this can be monitored by the teachers, in order for them to track the progress of student and tailor their lesson plans to target areas where pupils are
weakest. Existing educational sites such as Codecademy [10], allow schools and teachers to sign up and start integrating programming into their lessons. Teachers and students can login from their account at home and continue their lesson if they were unable to complete it in class. Codecademy can be used by teachers to check students progress and can assign them homework, create quizzes and even build their own courses [39].

2.3 Changes to the ICT Curriculum

The national curriculum changes are required to support desirable wider changes in other aspects of society as whole. The existing curriculum provides students with the knowledge traditionally required to enter a relatively predictable and stable range of lifetime employment opportunities. However with a rapidly changing global market, students need to be equipped for how to continuously update their knowledge, and how to adapt and apply their knowledge to a range of different working environments. Educational changes do not become visible overnight, but depend on how the teacher interprets the written curriculum. This can lead to teachers having a lack of confidence both professionally and personally due to not understanding the curriculum completely. However if teachers are able to see evidence that the new curriculum has, or is likely to have, a positive outcome on the students they are more likely to make an effort to understand what is required of them. With the national curriculum and new targets for what is ‘required’ and ‘expected’ from teachers continuously changing, it is what the teachers and students do in the classroom that determines what an educational change will achieve in any setting [46]. The new computing curriculum was compared to the current ICT curriculum and there was a significant amount of changes and improvements across all key stages.

2.3.1 Why Replace the Name ICT with Computing?

ICT as a subject name carries strong negative connotations of an outdated and not very challenging curriculum which does not help to prepare students for the future in the continuously changing global market [43]. There is also a confusion as to what ICT actually is: Is it a tool for learning in all subjects or is it a subject in its own right? [18] Changing the name from ICT is intended to improve the image of the subject due to the damage done to perceptions of ICT by the undemanding exams.

2.4 The New Curriculum

The new computing curriculum is concerned with how computers and computer systems work, and how they are designed and programmed. It is intended that pupils studying the new curriculum will increase their understanding of computational systems of various kinds and computational thinking will provide an insight into many areas of the curriculum [13]. Computing is recognised as an umbrella term for the subject, which comprises of three elements; computer science, information technology and digital literacy. The new curriculum includes much more programming and gives a far
greater emphasis on providing students with knowledge and understanding of computation and digital knowledge [43], however none of this was prohibited in the previous curriculum [13], [17]. Studying computer science allows the students to achieve a portfolio of mental tools labeled ‘computational thinking’, which include the ability to look for algorithmic solutions, patterns and ways of decomposing problems, skills rarely taught elsewhere in the national curriculum [18]. A huge benefit of the new curriculum is the emphasis on understanding, compared to skills learning. Students develop an understanding of ideas and principles, instead of training on a particular piece of software such as Microsoft Word [43]. The IT job market is becoming more dominant in job prospects and a study completed by the UK Council of Professors and Heads of Computing (CPHC) predicts that the number of jobs in the IT labour market will increase from 1,069,000 (2007) to 1,232,000 (2016), a growth of 163,000 or 15.2% [42]. The new curriculum is a step in the right direction for students and teachers. However research indicates that only 35 per cent of teachers already in the profession are formally qualified. Many teachers do not have the technical skills and programming experience to teach their students proficiently and therefore teachers will require investment in Continuing Professional Development (CPD) if they are to deliver the new programme of study to students proficiently [22]. The new curriculum provides teachers with scope to develop creative lesson plans, but the greater emphasis on computer science could result in other important elements of the computing curriculum, such as digital literacy and online safety, becoming neglected. Another concern of the new computing curriculum is that it will not meet the needs of businesses currently suffering from a severe e-skills shortage in employees [40]. The study conducted by UK CPHC shows that there is a large technical skills gap in the IT labour market, with 38% of IT Managers, 12% of Networking Staff, 10% of Programmers and 10% of PC Support Staff having insufficient technical skills [42].

2.5 Benefits of the New Curriculum

Scrapping the current ICT curriculum for a new curriculum which contains computer science and programming, has many benefits according to Michael Grove: “Imagine the dramatic change which could be possible in just a few years, once we remove the roadblock of the existing ICT curriculum. Instead of children bored out of their minds being taught how to use Word and Excel by bored teachers, we could have 11-year-olds able to write simple 2D computer animations using an MIT tool called Scratch. By 16, they could have an understanding of formal logic previously covered only in University courses and be writing their own Apps for smart phones” [12]. Richard Allan, Director of Policy at Facebook in Europe added that Facebook welcomes the proposed change to the ICT curriculum, and believes it will make the subject more interesting by allowing space for teachers to create an innovative curriculum which is relevant for young people.
2.6 Existing Online Learning Resources

There are numerous online learning resources already available for teachers and students, free of charge, to learn and enhance their skills for the current ICT curriculum. However as the curriculum is changing and programming is becoming more dominant, it was identified that there is also learning resources readily available which allow students to enhance their programming skills with the use of Scratch. The quality of each online learning resource varies quite considerably, as some online learning resources provide the user with a very basic explanation of what Scratch is and what it is capable of doing, and some provide the user with a large amount of learning material and tasks to complete. Through extensive research into resources for both the current ICT curriculum and resources which incorporate Scratch, a number of strengths and weaknesses were identified and are listed below;

2.6.1 Online Learning Resource A

One existing online learning resource which is suitable for the current ICT curriculum is www.bbc.co.uk/bitesize [5]. This design of this resource is very similar to what the present project is aiming for as it provides the user with lessons which they can work through, where examples are provided to the user through slides and videos.

Strengths

- Clear and easy to use.
- Easy to navigate to the required subject and Key Stage.
- Each lesson contains 3 options for a student; ‘revise’, ‘activity’ and ‘test’.
- The assessments provide instant feedback on a student’s understanding of a subject area.

Weaknesses

- The activity videos are long and do not require the students to complete an activity.

2.6.2 Online Learning Resource B

An established and successful learning resource for Scratch is www.learnscratch.org [25], which provides users with the options of video courses in both Spanish and English and also provides downloadable lesson plans. The video courses are split into Scratch 1, 2 and 3 and these three levels are split into several lessons which the user can work through. The learning resource provides the user with several different tutorials, allowing them to enhance and practice using Scratch. It also allows the user to download the project and the main script so they can look at the script in action instead of having to recreate what the video has just shown them. Instead the user can download the project and
then amend what is in front of them. This is an excellent feature for a Scratch learning resource as it can be extremely time consuming to recreate the project, in order to amend and enhance the project itself.

**Strengths**

- Each lesson provides the user with an objective which allows them to understand what they will be able to accomplish once they have completed that particular lesson.

- Each lesson is split into parts which follow on from each other.

- Each lesson has extension exercises, which allows users to enhance their skills further once they have watched the video.

- A selection of lessons provide the users with the option to view the main script for the video just demonstrated. This allows the user to view the script and recreate it within Scratch very easily, which can be extremely time consuming if the user is trying to capture it from the video.

**Weaknesses**

- Once users have started a lesson, they will not be able to proceed on to the next lesson unless they return to the index page.

- Each video resource does not contain any text explaining what the video is showing, therefore if a user is unable to watch the video they wouldn’t be able to complete the task at hand.

- The learning resource doesn’t set specific tasks for every lesson. It provides possible extension exercises for each lesson but is not consistent with tasks.

**2.6.3 Online Learning Resource C**

www.scratched.media.mit.edu [37] is an online learning resource for Scratch which provides users with stories, resources and discussion boards constantly updated not only by the site owners but any individual user using the site. The resources tab allows users to choose out of three options to identify the users level of experience within Scratch; “New to Scratch?”, “Familiar with Scratch” or “experienced with Scratch”.

**Strengths**

- It provides teachers with activities, lessons and handouts.

- A user can select the most appropriate level of experience and start their tutorials from there.

**Weaknesses**
• It is quite difficult to navigate around the site.

• The learning resource was focused at teachers resources, rather than students being able to complete the exercises themselves.

2.6.4 Online Learning Resource D

www.scratch.mit.edu [37] is an excellent Scratch learning resource which contains examples of projects completed by users across the world. It consists of a “try it out” link which incorporates Scratch into the web page, so users can use Scratch without having to download it on to their PC.

Strengths

• The learning resource is used by millions of users and so far 4,925,193 projects have been shared, therefore enhancing the material available.

• Users can try out scripts on the website by selecting “try it out” which is Scratch embedded into the website. This allows a user to use Scratch without downloading Scratch on to their PC.

• The learning resource is free to use and has received funding from Google, Microsoft and Dell to name a few.

Weaknesses

• It does not have specific lessons for a user to work through but does have a vast amount of project ideas from previous projects.

2.6.5 Conclusion

From identifying the strengths and weaknesses of four existing online learning resources, a list of features were identified as key to the success of the projects learning resource.

• The resource should be easy to navigate around and contain a clear navigation bar to all Key Stages and lessons.

• Videos contained in the learning resource need to be short in length, clear and concise.

• Each lesson needs to have an achievable objective.

• Lessons should broken down into manageable steps.
2.7 Best Practices in Online Teaching Strategies

There are a wide variety of educational technologies that are available for online teaching, but they are not all applicable to all subjects taught and to all teachers teaching styles. Bill Pelz was presented with the Sloan Consortium Award for Excellence in Online Teaching, and in 2004 he wrote a report which stated the three principles that lead to effective online pedagogy. Pelz’s first principle is to “let the students do (most of) the work” suggesting that the longer the period of time that a student spends immersed in the content, the more of that content they grasp [19]. Students should not be given the answer by the teacher, but work towards the answer with the help of a teacher. Pelz’s second principle is that “Interactivity is the heart and soul of effective asynchronous learning” [19]. Interactivity for the students can take place between students, with the teacher or in small groups or teams with regards to the course content, assignments and problem solving in lab activities. Pelz’s third principle is to “Strive for presence”, which can be broken down into three forms of presence which students should strive for in online learning environments; Social, Cognitive and Teaching Presence. [19]. This principle helps to establish a community of learning, where teachers and students are able to sustain discussions in a community and establish a personally meaningful and educationally worthwhile learning outcome.

Online teaching strategies can be broken down into three components;

- Planning and development of learning objectives. Must include consideration of the special needs of students e.g. disabilities.

- Teaching in action. Interaction among students and between students and their teachers.

- Student assessment and data evaluation. Student assessment enables students to assess their progress and the data collected can be used for future course redesign.

These three components together notably influence the effect of online teaching, and therefore for online teaching strategies to be effective teachers need to be aware of the best practice teaching strategies and how to use them to the best of their ability.

2.8 Evaluation of Web Resource Tools

The creation of the online learning resource will consist of web pages which combine Hyper Text Markup Language (HTML) and PHP: Hypertext Preprocessor, presented using Cascading Style Sheets (CSS). HTML is used to define the content of the website and CSS defines how the HTML elements will be displayed to the user [35].
2.8.1 Hyper Text Markup Language

HTML5 is a markup language which turns text documents into web pages [36]. A markup language is a set of tags used to provide a semantic description of a documents content. The web browser reads the HTML documents and uses the tags to determine how the content of the HTML pages will be structured and displayed to the user [35]. HTML is not concerned with the presentation of the web page to the user within the browser, that is the role of the CSS [36].

2.8.2 Cascading Style Sheets

CSS determines how HTML elements are to be displayed to the user. The external style sheets allows changes to the appearance and layout of the website by editing one file, which not only saves time but ensures that the website is consistent with its styling throughout. CSS also reduces bandwidth needs and therefore results in a faster load time and dramatically reduces the file transfer size [31]. With the limited time scale of the project it was decided that research should be undertaken into successful and reliable existing templates which could be amended for the online learning resource as it increases the speed of producing the online learning resource. As the website was being created for both students and teachers, the design needed to be considered as it needed to work well for both age groups. Researching several CSS frameworks revealed the two most appropriate to be Bootstrap [32] and Foundation [47].

2.8.3 Bootstrap

Bootstrap [32] is a free and open-source framework for creating front-end web development. It is fast, easy to use and is cross-browser compatible across all devices. Bootstrap can easily and efficiently scale a project with one code base, from phones to tablets to desktops, by adjusting the layout of the web pages accordingly. Developers continuously make contributions to the platform and therefore allow for constant release of bootstrap. This is demonstrated by 3.1.0 being released on 30th January 2014 and most recently 3.1.1 being released on 13th February 2014 [6]. Bootstrap provides pre-built CSS style sheets which include to name a few features; grouping of buttons, buttons with drop-down options and even a progress-bar. It also provides JavaScript components in the form of custom jQuery plug-ins which can be included individually or all at once. Twitter Bootstrap provides documentation and many examples to assist with first time users.

2.8.4 Foundation

Foundation [47] is also a free and open source front-end framework which lets you quickly prototype and create unique sites that work on any device with an extensive library of tested components. It uses technology such as jQuery, HTML5 Boilerplate and Normalizr as a baseline and then layers on top, components and plug-ins which are designed to work well in “all of our supported browsers and devices” [47].
2.8.5 Conclusion

After considering both CSS frameworks and taking into consideration the strengths and weaknesses, the decision was made to use a twitter bootstrap template and edit it to comply with the design ideas. This was decided as it was easy to use and provided a vast amount of templates which could be used and amended.

2.9 Validating Code

To ensure that the online learning resource is a well constructed website [24], it is beneficial for the code base to be validated against the latest W3C standards [45]. There are many reasons as to why validating code is important when creating a website as it not only teaches good practices but it is beneficial for identifying any errors and makes it easier to maintain for future use. It was decided to use the HTML5 version of HTML as it is the latest version and uses a new element which specifies a standard way to embed videos on to a web page [35], which is beneficial as the resource will contain many videos. HTML5 can be validated using the W3C validator site which can be found at www.validator.w3.org/ or an alternative is Adobe Dreamweaver. To validate CSS, even though it is less critical, it is important to strive for valid code on all fronts. CSS can be validated using www.jigsaw.w3.org/css-validator. To validate JavaScript, to ensure and enhance the functionality of the online-learning resource, use JSLint, which can assist with the checking of the construction of the JavaScript code. This can be found at www.jslint.com/.

2.9.1 Browser Testing

Website can look different in various browsers, as they can display content in different ways. To ensure that the learning resource is compatible across various browsers, it was required to test and retest the online learning resource in different browsers to ensure compatibility. Even though the consensus among current browser vendors is to comply to web standards, they adhere in different ways, therefore browser testing needed to be completed using such browsers as Chrome, Internet Explorer, Firefox and Safari.

2.9.2 Device Testing

The decision to create the website with mobile and tablet users in mind is mainly for accessibility reasons. Global mobile traffic now accounts for 15% of all Internet traffic [29]. We live in an age where no one screen size is dominant when it comes to browsing the web. In fact, there is no one screen size that has more than 20% of the global market share [3]. Mobile devices and tablets have become so accessible, even for young people, that creating a website for desktop only seems simply outdated and could very much become a frustration for users who would like to view it on a mobile device. Even though the website created for this project was aimed at a specific target audience
who were most likely be using the resource whilst at school, there is no reason in this day and age that anything made for the web should be developed for desktop only. Using bootstrap automatically made sure that the online learning resource was compatible across all mobile devices. Scratch is currently available for users to download from the app store for iPhones, iPods and iPads at a charge of £0.69 which allows users completing Key Stage 2 and 3 to use their mobile devices to complete the tasks. Currently the Kinect cannot be connected to any mobile device, but making the website compatible across all mobile devices allows for the opportunity for future advances.

2.10 Web Accessibility

When designing and implementing a website, the end users needs, goals and accessibility need to be taken into consideration. The Web Content Accessibility Guidelines 2.0 (WCAG 2.0) is a set of benchmarks and guidelines used by developers when producing accessible content. WCAG 2.0 includes the “principles, guidelines and the three levels of success criteria” [41], which work together to provide guidance.

2.10.1 The Four Design Principles of Web Accessibility

1. Perceivable – Information and user interface components must be presentable to users in ways they can perceive.

2. Operable – User interface components and navigation must be operable.

3. Understandable – Information and the operation of user interface must be understandable.

4. Robust – Content must be robust enough that it can be interpreted reliably by a wide variety of user agents, including assistive technologies.

2.10.2 Guidelines

The four principles are broken down into guidelines, which provide the basic goals which should be worked towards in order to make the website content more accessible for users with disabilities. By following the guidelines, the website content will be accessible to a broader range of people with disabilities, “including blindness and low vision, deafness and hearing loss, learning disabilities, cognitive limitations, limited movement, speech disabilities, photosensitivity and combinations of these.” [44]

2.10.3 Levels of Success

Each guideline is testable against a success criteria and this criteria identifies what must be completed in order to achieve success at various levels of conformance. The success criteria is organized
into three levels of conformance: A, AA and AAA [44]. The resource aimed to meet AA level of conformance, using the web accessibility evaluation tool, A-Checker [2].

2.10.4 WCAG 2.0 Advantages and Concerns

Advantages of WCAG 2.0

- Cooperatively developed international standards.
- Clear criteria, and therefore more precisely testable.
- Flexible and adaptable for different situations.

Concerns of WCAG 2.0

- Cognitive, learning and literacy difficulties - disabled groups are under-represented.
- Assignment of levels A, AA and AAA do not take into account important aspects of modern website creation.
- Conformance of the website is marked against achieving perfection in all success criteria at a given level.

WCAG 2.0 is an accomplishment in which website designers and developers adhere to a set of international standards, in the form of guidelines. Power, Freire, Petrie and Swallow [34] discuss the issue of certain disabled groups being under-represented.

2.11 Scratch

Scratch was developed by the Lifelong Kindergarten Group at the MIT Media Lab [37] and released in 2007. Scratch is based upon LOGO, a programming language created by Seymour Papert in the 1970s which allowed children to control the movement of a robotic creature with ‘move’ and ‘turn’ commands. In the 1980 a pilot project for LOGO began in a school in Texas and 6 New York schools, where these projects have had lasting results. Over the last 30 years the prototype used in the pilot project evolved into commercial products used by teachers throughout the world. However LOGO failed to have a big impact on the imagination of both teachers and students [28]. The Lifelong Kindergarten Group developed a new LOGO programming environment called Scratch which is simple to learn yet a powerful programming tool. It enables young students to think creatively and work collaboratively by moving blocks of code to build a script that tells sprites how to act. Within Scratch students aged 8 and upwards can program their own interactive games, music projects and create multimedia applications with ease and it can also gather information from the outside world via a sensor board connected to the computer.
2.12 Kinect

The Kinect is an accessory to the Xbox 360, which enables motion and gestures to control game functions. Using the Kinect to teach students can transform ordinary classroom activities into memorable learning experiences, which break through learning barriers with fun, active and easy-to-play classrooms games. The Kinect not only allows students the opportunity to develop their programming skills but it also promotes physical activity as part of the learning process as they use their entire body when using the Kinect [30]. To incorporate the Kinect with Scratch was originally proposed by a teacher from a local school, and with further research it was established that the Kinect is used in many classrooms right across the world already. KinectEDucation is one of many online communities which promotes the use of Kinect applications in classrooms and encourages students to “explore innovative learning opportunities within the controlled setting demanded by the structure of public education” [23]. The Kinect has been used for the computing syllabus as demonstrated by Johnny Kissko, who created ‘KineSis’, a project which allows you to control presentations using the Kinect. The students can open documents and control presentations, such as moving to the next slide and scrolling. The Kinect is not only used within the computing subject syllabus but within other subject areas such as maths. An example of how the Kinect can be used within maths is demonstrated by Jack Chang, who created ‘Kinect Math - A Kinesthetic Learning Experience’. The Kinect Math allows teachers to make abstract mathematical concepts more interactive using the Kinect. Students can manipulate graphs, variables and much more [9].

2.13 Requirements Revisited

After completing the background reading for the online learning resource it was decided that as Scratch is designed for students aged 8 and above, it would not be suitable for Key Stage 1 students. It was therefore decided that the Key Stage 1 section of the website would be replaced with a ‘Basics’ section, where students would learn about what Scratch is, what can be achieved with the block palette and how to duplicate blocks of code. Lesson five of the ‘Basics’ section will then explain how to create a simple program within Scratch which they can build upon within Key Stage 2.

2.14 Summary

This chapter has looked at the new computing national curriculum and why particular changes have occurred, (see section 2.3). To gather a greater understanding of why an online learning resource is successful, the strengths and weaknesses were identified for four different resources and from these, clear ideas for designing the new learning resource were identified. The background research identified two additional forms of evaluation for the online learning resource. The first evaluation method identified was evaluating the website for valid code, using www.validator.w3.org/. The accessibility of websites was identified as an important function of any website and therefore the second
website evaluation method identified involved using the accessibility checker. A combination of both were used to ensure compliance with internationally accepted web standards.
Chapter 3

User Study of Existing Resource

This chapter of the report details the user study undertaken into www.scratch.mit.edu [26], the creator of Scratch. It will cover the method, procedure and results of the study.

3.1 Introduction

As identified in Section 2.6, there is a number of existing online learning resources for both Scratch and other subject areas, for both teachers and students to use. It was decided to use www.scratch.mit.edu as the learning resource for the user study as it is the original creator of Scratch [26], and identifies all of the basics required for Scratch. It was decided to use the Think Aloud protocol as it allows the author to understand the thought process of the user as they use www.scratch.mit.edu. The think aloud protocol allows users to explain their method of attempting to complete a task, which enables an in depth understanding of any difficulties they encounter in the process. These difficulties can be noted and can be taken into consideration when designing the online learning resource.

3.2 Method

3.2.1 Participants

Six participants were recruited to take part in the user study, of which two were female and four were male. All the participants had never used Scratch before and therefore were new to the whole concept. The participants each attended different schools across the country, so were all exposed to different teaching styles. Testing took place in March 2014.
The consent form informed the participants that they were able to withdraw from the study at any time and they were free to refuse to answer any questions. The participants were also provided with an Information Sheet explaining to them the reason for this user study, how long it should take and how their data would be used. The participants were told that the user study was testing the instructions within www.scratch.mit.edu, not the user and that any difficulties were the author’s fault, not theirs. The Think Aloud procedure was explained to all the participants and a practice Think Aloud task was conducted to ensure that the participants were familiar with the procedure. The procedure was practiced by asking each participant to count all of the windows in their house, making sure that they explained their process in sufficient detail.

3.2.2 Procedure

The participants were asked to follow the first 11 steps on www.scratch.mit.edu, which were a step-by-step introduction to Scratch. The participants were informed that they needed no prior knowledge of Scratch and that they would be timed for each task. The participants were encouraged to use the Think Aloud protocol and were informed that there would be 11 tasks to complete, followed by a simple questionnaire.

The tasks set were as follows:

- Task 1 – Start Moving – Participants were asked to make the Sprite move ten steps.
- Task 2 – Add a sound – Participants were asked to add the sound block “Play drum 1 for 0.2 beats” to the script.
- Task 3 – Start a Dance – Participants were asked to follow step 3 and “Start a dance”.
- Task 4 – Again and Again – Participants were asked to introduce a repeat loop.
- Task 5 – Say Something – Participants were asked to add a ‘say’ block which said “Watch me dance!”.
- Task 6 – Green Flag – Participants were asked to follow step 6 and introduce the Green Flag, so that the script started once the green flag had been clicked.
- Task 7 – Change Colour – Participants were asked to add a ‘Looks’ block to change the colour of the sprite.
- Task 8 – Key Press – Participants were asked to follow step 8 and introduce a ‘When Space key pressed’ block.
- Task 9 – Add a Backdrop – Participants were asked to create or upload a background to their program.
• Task 10 – Add a Sprite – Participants were asked to follow step 10 and add an additional sprite to their program.

• Task 11 – Add sounds and costumes – Participants were asked to add additional sounds and costumes to their new sprite to make their sprite look like it was dancing.

3.2.3 User Feedback

In addition to the tasks previously specified, all the users were asked to complete a questionnaire after completing the tasks. It was decided to use a questionnaire as an additional technique for gathering data as additional information such as their overall opinion of the number of steps and the use of images and videos. Questionnaires were a good technique used for collecting qualitative data, as the format is familiar to most respondents and should be quick for them to complete but also straightforward to analyse.

The questions on the questionnaire asked the participants:

1. Were the 11 steps easy to follow?

2. Did you like the steps being small or would you prefer fewer steps with bigger tasks?

3. Did you find the images and videos useful?

4. Did you use just the text, just the images or a combination of both to help you complete the task?

3.3 Results

This section focuses on the results of the user study. This incorporates the time taken to complete each individual task, feedback from the Think Aloud protocol and answers to the questions asked within the questionnaire. Results from the user study showed that three out of the six participants liked the fact that the steps were small and manageable, and made them feel like they had less work to do. Three participants voiced the opinion that they preferred having a greater number of smaller tasks to complete. They felt a greater sense of achievement when they had completed five out of the eleven tasks and became stuck on task six compared to if there was only six tasks and they had complete two tasks and became stuck on task three out of the six tasks. They thought that, even though they were stuck on the same task, five out of eleven sounded like a greater achievement than two out of six. The other three participants did not like the fact that there were eleven small steps and they would have preferred six tasks which were twice as long as the tasks on www.scratch.mit.edu. All six participants found the images and videos useful in completing the tasks and used a combination of both images and text to work through and complete the tasks set.
3.3.1 Time Taken to Complete Tasks

All six participants completed all eleven tasks. Figure 3.1 shows the average time take for the six participants to complete each task.

Figure 3.1: Average Time Taken To Complete Each Task

Figure 3.1 shows that as the tasks became more complicated, the longer it took for the participant to complete. The times collected allowed for predictions in the time it would take for a student to complete the tasks within the online learning resource.

3.3.2 Feedback from the Think Aloud Protocol

Task 1
This task was completed by all participants and was the quickest task to be completed out of the eleven tasks. Some participants did not immediately understand that they needed to click on the “move 10 steps” block in order to make the sprite move 10 steps. This resulted in the participants re-reading the task for a second time to understand how to move the sprite.

Task 2
This task was completed by all participants, however one participant did not use the correct sound block. This participant did not understand that they had to use the sound block specified in the image and therefore selected one which they wanted. Three participants did not change the number of beats they needed to select (0.20 beats), instead they used the default number of beats (0.25 beats).
Task 3
Task three was completed by all participants correctly and all the participants who had incorrect blocks of code from task 2 rectified their errors. Three participants expressed annoyance that the images were placed too close to each other within the instructions and therefore made it confusing to distinguish between the different images.

Task 4
This task was completed by all participants, however one participant found it difficult to understand how to make the ‘repeat’ block surround all the other blocks. After re-reading the task, they managed to complete the task. Five out of the six participants selected the ‘Events’ tab first before realising they needed to select a block of code from the ‘Control’ tab. The feedback showed that the participants selected the wrong tab because the image of the repeat block within the instructions looked like the colour of the ‘Events’ tab.

Task 5
Task 5 was completed by all the participants correctly. Feedback expressed that this task was simple to complete but some participants were not aware that they need to change the time on the ‘say’ block until they were about to move on to the next task and then realised they needed to do so before they could move on.

Task 6
This task was completed by all participants. None of the participants had any problems with the task of adding the addition block of code, but one participant did not understand that they had to select the green flag to start the script. This participant continued to click the stack of blocks in order for the sprite to move, which worked for the participant. Three out of the six participants again went to the ‘Control’ tab to find the block and realised that it was the wrong tab. Feedback stressed that the colour difference between the ‘Control’ and ‘Events’ tabs was minimal and therefore it was not obvious which colour needed to be selected.

Task 7
Task 7 was completed by three participants. The other three participants tried to add the ‘Change color effect by 25’ block to the stack of blocks instead of leaving it in the script on its own. Feedback suggested that the image was not clear that the block needed to be separate from the existing stack of coded blocks.

Task 8
This task was completed by all the participants correctly. The three participants who placed the ‘Change color effect by 25’ block in the incorrect place rectified their problem and went on to task 9.
with the correct blocks of code within the script. One participant placed the wrong ‘Events’ block on
top of the “Change color effect by 25” block and struggled to figure out how to separate the blocks
from one another in order to attach the correct block of code. The participant tried to drag the incorrect
‘Events’ block away in the same manner as when they dragged it on to the stack before. After trying to
pull the “Change color effect by 25” block away, they understood how to change the incorrect block.
Feedback suggested that the image in task 7 was not clear that the block needed to be separate from
the existing stack of coded blocks.

Task 9
Task 9 was completed by all the participants correctly. One participant took a little while longer than
other participants to find the image to click on to choose a new backdrop and the feedback from that
participant suggested that the image needs to be clearer so that participants have a greater chance of
understanding the picture and subsequently locating the backdrop tab.

Task 10
Task 10 was completed by all participants, but three of the participants selected their own sprite in-
stead of selecting “Cassy Dancing”. The three participants who selected the incorrect sprite did not
understand how they could change the sprite to the correct one. Two of these three participants created
a new sprite and deleted the incorrect sprite. The other participant did not understand how to delete
the incorrect sprite and left it. General feedback from the participants for this task was that they did
not read the whole set of instructions before starting the task. They only realised they had chosen the
wrong sprite at the end once they had chosen their new sprite.

Task 11
This task was completed by all participants and was the task which took the longest for all participants.
One of the participants did not understand where they needed to find the “Next Costume” block. After
looking at the colour of the block, they realised that they needed to go to the looks section and find
the correct block.

3.3.3 Feedback from the Questionnaire
This section summaries the qualitative feedback captured for each of the 4 questions given to the par-
ticipants within the questionnaire.

Question 1 Question 1 asked “Were the 11 steps easy to follow?” Every participant answered this
question with “Yes”.

Question 2 Question 2 asked “Did you like the steps being small or would you prefer fewer steps
with bigger tasks?" Three of the participants said that they preferred the small steps than bigger steps as they felt when they got stuck on a task they looked at how many steps they had already completed and felt better with the larger number of task completed than if there were only 6 tasks. The other three participants had the opposite opinion and would have preferred less steps so that they did not have to keep moving on to a new page every minute or so.

**Question 3** Question 3 asked “Did you find the images and videos useful?” All of the participants thought that the images were extremely useful and 5 participants said that they do not think they would have been able to complete the tasks set without the images. All six participants did not realise that there were videos.

**Question 4** Question 4 asked “Did you use just the text, just the images or a combination of both to help you complete the task?” All six participants used a combination of images and text to complete all eleven tasks. One participant said that “If the images of the blocks were not there with the different colours, I don’t think I would have been able to find any of the blocks that I needed from just reading the text.”

### 3.4 Summary

From the user study it was found that some users did not copy what the image exactly shows and there should always be text next to the image that reiterates what the image is showing. The data also showed the importance of ensuring that images of blocks of code are clear and separated appropriately to avoid confusion as to which blocks of code are meant to be placed together. The data also showed the importance of ensuring that the images are clear and show the blocks of code in the correct colour.
Chapter 4

Design

This chapter contains a detailed evaluation of the tools considered for use during the solution design. The resource was chosen to target teachers who teach students, from Key Stage 2–4, and to include a basic chapter which students could use to familiarize themselves with the basic functions of Scratch. If the students using the online learning resource were aware of how Scratch functions, then they were able to move straight onto Key Stage 2 lessons.

4.1 Benefits of Proposed Solution

The benefit of the proposed solution is that existing online Scratch resources demonstrate what you can achieve with learning to use Scratch but do not provide activities that will enhance a student’s experience. The proposed online learning resource allows students to design, write and debug programs to accomplish goals and to also use logical reasoning to explain how simple programs work and to detect and correct errors. The online learning resource can be used by anyone who accesses the website and when a teacher wants to use the resource during their lessons, their students have the ability to email them showing their progress. The teaching material within the online learning resource combines the benefits of existing learning resources, such as www.learnscratch.org [25] which consists of detailed video lessons and http://scratch.mit.edu [37] which consists of images and small steps instead of videos. The proposed online learning resource takes into consideration different learning styles and combines videos, images, snippets of Scratch code into activities and stores them in one central location. The online learning resource encourages students to complete the steps for each lesson at their own pace and submit their progress to their teacher via the submission page.
4.2 Functional Requirements

The functional requirements of the online resource were identified below;

- A index page explaining the purpose of the online learning resource.
- A set of lessons for each Key Stage.
- An objective for each lesson and how the objectives relate to the new computing syllabus.
- Downloadable snippets of Scratch.
- Clear layout of steps, which flow easily on to the next step.

It was decided that the project would not contain a forum for students to share problems or solutions for the online resource. This was decided as it avoids any possibility of cyber-bullying and keeps each student anonymous.

4.3 Lesson Tasks

The lesson tasks were created to ensure that the targets of the new National Curriculum for Computing were met for each Key Stage. A subset of primary and secondary school teachers evaluated the lessons created and provided feedback on the difficulty and duration of each step during each iteration. The MIT Media Lab [26] designed Scratch especially for children aged 8 – 16 which is the age range covered by Key Stages 2-4, therefore it was decided that children who were currently studying at Key Stage 1 would be too young to complete the tasks designed within the online resource. It was decided that the online learning resource would be aimed at students within Key Stage 2 – 4 as students are required to have an understanding of Scratch before they could use the Kinect to play games within Key Stage 3 and 4. With this in mind, it was decided to include an additional tab called ‘The Basics’ which explained how to use Scratch and provided a background into what is possible within Scratch.

The initial learning objectives for each Key Stage that were chosen were;

**Key Stage 2**

- Use sequence, selection, and repetition in programs
- Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs.
- Design, write and debug programs that accomplish specific goals, including controlling or simulating physical systems; solve problems by decomposing them into smaller parts

**Key Stage 3**

- Understand simple Boolean logic [for example, AND, OR and NOT] and some of its uses in circuits and programming.
Key Stage 4

- Develop their capability, creativity and knowledge in computer science, digital media and information technology.

- Develop and apply analytic, problem-solving, design and computational thinking skills.

The ideas for the tasks and games for the online learning resource were gathered from the user study, evaluating existing online learning resources and the Scratch website [26]. The Scratch website displays starter projects for users to complete and also displays projects which range from stories to art to even music game published by users worldwide. When gathering ideas, it was essential to ensure that the games would address the learning objectives for each Key Stage and be enjoyable for the students to complete. The games needed to range in difficulty for each Key Stage and needed to be easy to break down into simple steps for the students to complete. The purpose of the online learning resource was to make programming more enjoyable and interesting, so the games needed to be exciting and different to fulfill this purpose and to keep students engaged.

4.3.1 Basics

The basics section allowed children to get to grips with simple functions within Scratch before they were set lessons within Key Stage 2. It also ensured that all of the students had the same knowledge and understanding of Scratch before they started the Key Stage 2 lessons. The basics section explains the different categories within the block palette, how to move a Sprite, how to change a Sprite’s costume and finally how to create a simple program. It also provides students who did not use Scratch whilst they were in Key Stage 2, a basic understanding of how to use Scratch before they went on to complete Key Stage 3 and 4 lessons.

As the basics section does not address any learning objectives, ideas of what should be included within the section were gathered from, the feedback from the user study undertaken in chapter 3 and from the author’s personal experience of learning how to use Scratch. MIT Media Lab [26] created an 11 step guide to understanding Scratch within their website which was used during the user study completed in chapter 3. At each step they introduced an additional block, so that users gradually built up a program using several different blocks. Using the feedback from the user study it was decided that a similar process should be used within the basics section.

- Lesson 1 – Explain what Scratch is, what a sprite is, the different areas within Scratch, how to save a program and how to create a new background.

- Lesson 2 – Explain what is inside each coloured block (Motion, Looks, Sound, Pen, Control) by splitting it into five simple steps and creating a simple task for each step.

- Lesson 3 – Explain what is inside each coloured block (Sensing, Operators, Variables) by splitting it into three simple steps and creating a simple task for each step. The last two steps
required creating a “What does the sprite do” task, where the student will need to look at the image and predict what the sprite will do.

- Lesson 4 – Explain what the ‘Green Flag’ is and where it is located, explain how to delete and duplicate blocks of code and ask the students what certain blocks of code would do.

- Lesson 5 – Start to create a program using what they have learnt in the previous four lessons, which will include moving the sprite, changing the colour of the sprite and changing the sprites costume.

### 4.3.2 Key Stage 2

With Scratch being designed for students aged 8 – 16, Key Stage 2 was the earliest age for students to try using Scratch. With the basics of Scratch being covered in the basics section, it was possible to look at the learning objectives selected above and design tasks which addressed these.

The first learning objective “Use sequence, selection, and repetition in programs” was addressed in the first lesson where the students were introduced to conditionals and loops. Within Scratch conditionals are broken down into IF and ELSE statements and loops are broken down into FOR and WHILE loops. WHILE loops were not used in Scratch and therefore the focus was on FOR loops. To ensure that sequence, selection and repetition were used in the programs, it was decided that the students should download snippets of Scratch and amend the sequence within the program to complete a task.

The second learning objective “Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs” were addressed during the second lesson where students were required to download snippets of Scratch and explain what each program did. The aim of the tasks were for the student to look at the blocks of code and then describe what the blocks of code will do. If the students became stuck, they could play the script and work it out from that extra bit of help. The final two steps within the second lesson required the students to download snippets of Scratch and ‘detect and correct’ the errors to ensure that the program did what the task asked of them.

The third learning objective “Design, write and debug programs that accomplish specific goals, including controlling or simulating physical systems; solve problems by decomposing them into smaller parts” was addressed by using three lessons to create a ping-pong game. The students were required to design and create their own ping-pong game by decomposing and completing the game in small and simple steps. The creation of the ping-pong game was split into four separate goals; the first goal was to create the ball, the second goal was to create the left paddle, the third goal was to create the right paddle and the final goal was to create the points system.
4.3.3 Key Stage 3

Key Stage 3 expanded on Key Stage 2 and addressed the learning objective “Understand simple Boolean logic [for example, AND, OR and NOT] and some of its uses in circuits and programming”, by introducing boolean logic to the students. To ensure that the tasks were interesting, research was undertaken into what games had been created in Scratch using http://scratch.mit.edu/ [26] and it was finally decided that it would be exciting to create a Mario game.

The first lesson introduced the student to boolean logic within Scratch, where there are two types of booleans; conditional and comparative booleans. The tasks were open ended which allowed the students to be creative and create a program that incorporated both types of booleans. The first lesson also introduced the students to gravity and velocity so that they were able to make their Mario character jump on to platforms during their second lesson. The Mario game also incorporated what the students had learnt in Key Stage 2, by using ‘IF’ and ‘ELSE’ statements and during the third lesson the students started to use boolean logic when moving their character left and right.

4.3.4 Key Stage 4

By Key Stage 4 the students had built two unique games within Scratch, a Ping-Pong and Mario game. In Key Stage 4 the Kinect was introduced and the first lesson explained how to use the Kinect. The introduction of the Kinect was first suggested by a teacher from a local school and with further research into using the Kinect with Scratch it was identified that Stephen Howell [21] had developed Kinect2Scratch in 2012. Stephen had developed his own software which allowed users to connect Scratch with the Kinect. His website www.scratch.saorog.com allows users to download the software and see example games which he has created. Using this software an example game was designed which was broken down into several lessons. The first step for lesson one was a simple task which asked students to move a sprite around the stage using their hands. With this simple and easy introduction into using the Kinect, the students then went on to amend the games they created in Key Stage 2 and 3 so that they could control them using the Kinect.

The first learning objectives of Key Stage 4 was to “Develop their capability, creativity and knowledge in computer science, digital media and information technology”. This learning objective was addressed during lesson two where the students were required to be creative and start to build a unique game. The students were required to design and build the game using the steps on the resource, which eventually enabled them to control it using the Kinect.

The second learning objective of Key Stage 4 was to “Develop and apply analytic, problem – solving, design and computational thinking skills”. This learning objective was address during lesson 4 and 5 of Key Stage 4, where the students were required to use all of their skills gained from Key Stage 2, 3 and 4 and design their own game using the Kinect.


4.4 Pre-Prototyping

Once the tasks for each Key Stage were decided, the pre-prototyping iteration was initiated. The stage acknowledged as pre-prototyping involves becoming familiar and competent with the technology chosen. HTML and CSS were languages taught in the University of Leeds Information Technology syllabus during the first year, and therefore did not require much further learning but PHP did require further learning to understand how to incorporate it into HTML. Before a prototype could be established, a site map was created in order to plan how many web pages the website will contain and this is available in appendix D.

Much of the pre-production stage was spent becoming familiar with the functions within Scratch and designing the tasks required for the online learning resource. The use of Kinect and Scratch was extensively researched and practiced before designing the prototype and creating steps for the students to complete. This was researched in order to see what types of tasks would be enjoyable for students to complete, where their ages ranged from seven-sixteen but to also tick off against the targets set by the Department of Education. Each lesson was designed to be completed within a student’s one hour computing lesson.

4.5 Prototyping

To start the initial design phase, two paper prototypes were designed, one for the index page and one for lesson 1. The two prototypes are shown in Figure 4.1 and a larger copy is available in appendix E. The prototypes of the website were created in order to demonstrate to teachers the uses of the resource and to confirm the requirements of the resource. The prototype comprised of the basic functionality and demonstrated the layout of the online resource which met a number of the minimum requirements. This low fidelity paper based prototypes were originally planned to be evaluated by students within the School of Computing at the University of Leeds and teachers at both primary and secondary schools.
4.5.1 Benefits of Prototyping

Building a prototype of the online learning resource had many benefits and these are listed below;

- Time was saved during the implementation stage, which was essential with the time constraint for the project.

- Users were actively involved in the development and provided feedback on task ideas before implementation.

- Requirements were validated before implementation which led to a quick implementation.

4.5.2 Prototype Evaluation

Once the initial prototype was created, it was originally planned that teachers would evaluate it and provide feedback. Unfortunately due to not receiving any responses to emails to teachers in the local area, it was decided to recruit five School of Computing students to evaluate the two prototypes created. Since all first year Information Technology students undertake a web development module and all third year Information Technology students have the option to undertake a usability design
module, they had the prior knowledge to create a well designed website. Feedback from the evaluators is shown below;

- Index page – General feedback suggested that the Key Stage information boxes should be larger in size and an image should be included which shows the end results for each lesson. It was also suggested that each box should contain a hyper-link to the first lesson of each Key Stage. This would enable users to access the first lesson for each Key Stage quicker.

- Lesson One – Feedback suggested that each lesson page should have a title which states which Key Stage and which lesson the user was currently located on. Feedback also indicated that the steps of lesson one were very close together and should be changed so that each step followed on from the previous step in a vertical fashion. Participants pointed out that the images were too small and therefore would be difficult to see at the current size. If the steps were shown vertically, it would allow for each step to have either more images or for the existing image to be larger which would be beneficial to the user.

- Colour Scheme – The prototype did not explain what the exact colour scheme would be and it was suggested that the colour scheme should be finalised before iteration one is implemented.

Before implementation started, a mock-up of the index page was created using balsamiq mock ups [4], which took into account the feedback for the prototype evaluation. This provided a basis of what the website would look like during iteration one.

![Figure 4.2: Prototype of the Index page using Balsamiq mock ups](image)

4.6 Summary

This chapter looked at the new national curriculum for computing and identified which learning objectives the online learning resource would be addressing. Research was then conducted, which involved
looking into pre-existing games that would be suitable for this project. Ideas were gathered based on the findings from this research, ensuring that each idea addressed the learning objectives for each Key Stage. Once the tasks had been decided upon, findings from evaluating existing online learning resources (see Section 2.6) were used to design the initial layout of the website and two low fidelity paper based prototypes were created. The low fidelity prototypes were evaluated by five School of Computing students and this feedback was used to create a more advanced prototype with balsamiq mock ups, ready for iteration one.
Chapter 5

Implementation

This chapter explores the issues and challenges that were encountered during the implementation of the online learning resource. It will look at the approach taken to the project, the tools used in development and also the various iterations that were completed prior to the final online learning resource being produced. Given the time constraint of the project, testing was not able to take place at schools and therefore a selection of students of different ages were recruited to test the resource. Two teachers were also recruited for evaluating the resource.

5.1 Tools Used

At the start of the project when it was decided that an online learning resource was going to be created, a mind map was created which listed the initial ideas of potential domain names. Heng [20] emphasized that it would be beneficial to have a domain name that reflected the website’s content, so that visitors had fewer things to remember when searching for the website. He also emphasized that the domain name should be the name that is being used to advertise the resource, as that will be the first thing that any visitor will try to search for in their browser. After much consideration it was decided to use www.kinectwithscratch.co.uk as the domain name for the online learning resource as it combined both the words Scratch and Kinect within the title. Once the domain name was decided, research was conducted into choosing an appropriate hosting service which was reliable and cost-efficient. Three hosting service were considered: godaddy.com, 123-reg.co.uk and Tsohost.com. After research into each hosting service and using recommendations from experts, Tsohost [33] was chosen as it had received excellent reviews from its customers for its customer service, its control panel access and its ease and simplicity for creating new websites.
5.2 Approach Taken

The project was started with the production of a rapid prototype, where each prototype was designed, created, implemented and then evaluated. Each iteration was evaluated by the observation of students and the completion of questionnaires. It was decided to observe the students as a form of evaluation as it provides a real picture of the user’s behavior and provides information on what the students did and did not understand when using the resource. Once the students had completed the lesson they were asked to complete a questionnaire, which asked for their opinions on the tasks they completed. It was decided to use a questionnaire as an evaluation method as they were quick and easy for the students to complete. The questionnaire for the students was designed with their age range and therefore for each question, students were asked to circle the answer most appropriate. It was decided to conduct an unstructured interview with the two teachers, as unstructured interviews provide rich information and allow the teachers to answer the questions in as much detail as they want to. The unstructured interview also provided flexibility for the interviewer as the questions could be adjusted as the interview took place.

5.3 Iteration One

The first iteration of the online learning resource closely followed the original mock-up designs in Figure 4.2. Feedback was gathered from the user study and the conclusions from evaluating existing online learning resources. The first step in the development of the first iteration was creating the web pages in HTML. Sublime was chosen as the text editor, as it had been used on previous occasions and was found to be extremely efficient and easy to use.

5.3.1 Index Page

The layout of the index page was created first and once completed it was duplicated so that all of the web pages were consistent with each other and contained the same navigation bar and house style. The index page was changed slightly from the initial mock-up in Figure 4.2 as it was decided that the images within the prototype were too tightly compact and therefore they should be moved down the page slightly and centered. The text explaining the purpose of the online learning resource was centered so that it is the first thing that the visitors saw when entering the website. The first iteration of the index page is shown in Figure 5.1.
5.3.2 Basics, Key Stage 2, 3 and 4 Lessons

Feedback from the user study identified that all six participants used the images to identify the task at hand and then used the text to check to see if the task had been completed correctly. It was decided that images of the required coded blocks were essential for students to understand what was required of them at each step. Therefore it was decided that for the second iteration each step would include an image showing either the coded blocks which should already be in the students’ program from previous steps, an image of what the program should look like once the step has been completed or an image showing what the stage should look like. Including an image of the coded blocks which should have been added to the program from previous steps was essential in order for the students to start the next step correctly.

5.3.3 Scratch Snippets

From the background reading into existing online learning resources it was decided that the online learning resource would work well if students could download snippets of Scratch code which they could then amend. Students could then use both the Scratch code that they had downloaded and the image to understand what was required of them to complete the step. This would not only save the students time when creating a game but it would also be useful for students to identify errors in the code, which is a key target set in the new computing curriculum. Figure 5.2 displays Step 3, which includes a snippet of code to download and amend in order to complete the task.
5.3.4 Evaluation

As stated in section 5.2, it was decided to use a questionnaire as an evaluation method for the six participating students, to ensure that the process for gathering feedback for each iteration was consistent. The questionnaire for the students is available in appendix J.

The first iteration was unveiled at a presentation to the supervisor and other final year undergraduates. Feedback on the design and appearance was given and taken into account for the design of the website for the second iteration. Interviews with both primary and secondary school teachers provided feedback on the tasks designed for the students on the website. The teachers were of great benefit for identifying how long a task would actually take a student in a classroom setting. The first iteration was also tested on six students whose ages ranged from eight to sixteen, from all different key stages.

The feedback from the supervisor and other final year undergraduates suggested that it would be beneficial for each lesson to have a title which identified where the user was located within the website. During iteration one, the only way to identify where the user was located within the website was to look at the URL, which many students did not realise.

When conducting interviews with primary and secondary teachers, the suggestion of a submission page was introduced by the author. The submission page would allow students to document which steps they had completed and enable students to email their teachers and attach the programs which they had created after completing the lesson set by their teacher. With students being able to attach their Scratch programs to the email, it would allow the teachers to view the students programs and confirm that they have completed and understood the objectives set for that particular lesson. From the submission page the teacher would then be able to document which steps and which lessons were completed by each student and then either set extra homework and help to assist in their planning.
for future lessons dependant on the progress of each student. The idea of the submission page was encouraged by both the primary and secondary teachers.

The feedback from the questionnaires for the students suggested that the introduction of videos to the website would be very beneficial and assist them with complicated tasks. It was identified that one user who is dyslexic always looked at the image first before reading the text and then tried to create what the image showed. From this finding, it was decided that the image next to each step should show part of the code which was required to complete the task instead of an image of what the sprite should look like once that particular step has been completed.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Key Stage</th>
<th>Lesson</th>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
<th>Step 4</th>
<th>Step 5</th>
<th>Total Time Taken</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Key Stage 2</td>
<td>Lesson 1</td>
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<td>50</td>
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<td>50</td>
</tr>
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<td>Lesson 3</td>
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<td>3</td>
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</tr>
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<td>16</td>
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<td>49</td>
</tr>
<tr>
<td>Participant 5</td>
<td>Key Stage 4</td>
<td>Lesson 1</td>
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<td>5</td>
<td>50</td>
</tr>
<tr>
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<td>20</td>
<td>7</td>
<td>20</td>
<td>N/A</td>
<td>50</td>
</tr>
</tbody>
</table>

Table 5.1: Participant Results - Iteration One

5.4 Iteration Two

The second iteration of the online learning resource used the feedback from the first iteration and it was decided to create a submission page for the students to upload their Scratch programs and email their teacher on their progress during each computing lesson. It was also decided that each page required a title which allowed the user to identify where they were located in the website. From the feedback from the student’s questionnaires it was decided to create videos in addition to the images for the specific steps which students found difficult or misleading.

5.4.1 Submission Form

In order to develop a submission form, it was decided to use PHP: Hypertext preprocessor as it is simple to use and quick at generating dynamic elements on websites. PHP is open source and readily available to be developed in the community which generates code which is secure and stable [31]. PHP is cross-platform and therefore enables operation across various operating systems such as Windows, LINUX, UNIX and Mac OS X platforms which is extremely beneficial to an online learning resource as different schools will have different operating systems available to their students [35]. It is a server side scripting language which works quietly on the server side to create rich interactive websites which allow for a comfortable and seamless user experience. PHP was chosen as it is in-
credibly fast to develop and integrates seamlessly with HTML code, which was already being used within the website. With no previous experience of PHP, it required a lot of background reading into how to develop a submission form where students could attach files and send emails to their teacher to view. Within the submission form it was decided to add several fields for the students to complete. Figure 5.3 shows the submission page.

![Figure 5.3: Submission Page](image)

5.4.2 Basics, Key Stage 2, 3 and 4 Lessons

Using feedback from the first iteration, each web page introduced a title which identified to users which page they were on within the website. Figure 5.4 shows the change.
5.4.3 Videos

Feedback from the first iteration suggested that the introduction of videos would be better for explaining how to complete certain steps compared to using an image. W3schools website [35] identified that it can be difficult to ensure that videos will be compatible with all browsers and also play on all hardware. There were three different ways of embedding the videos into a website; using a `<embed>` tag, using a `<object>` tag or a HTML5 `<video>` tag. After considering the three different options, it was decided to use customizable `<video>` tag to ensure that the videos worked on different browsers and hardware. This required converting each video into different formats, and then adding a fall back message which displays text saying “Your browser does not support the video tag” which provides the user feedback as to why they can not view the video. Figure 5.5 shows the video created for users to understand how to delete a block of code.
5.4.4 Evaluation

The second iteration was tested by a further six students whose ages ranged from eight to sixteen. Interviews were also conducted with the same primary and secondary teachers used in iteration one.

Feedback from the teachers interviews suggested that certain lessons were too long for a one hour computing lesson and with certain lessons on the website, students were only managing to complete up to step four. These lessons were identified and were simplified to ensure that the lesson could be completed within 50 minutes. Feedback also suggested that the Kinect was very temperamental and every time a new program was either started or downloaded the Kinect needed to be reset. Therefore it was decided that for each lesson the students should work on creating one program, and not switch between several different games. For the second iteration the steps for Key Stage 4 were amended so that one program was created during each lesson to ensure that the Kinect did not need to be reset thus avoiding any connection problems with the Kinect.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Key Stage</th>
<th>Lesson</th>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
<th>Step 4</th>
<th>Step 5</th>
<th>Total Time Taken</th>
</tr>
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<td>Participant 1</td>
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<td>Lesson 1</td>
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</tr>
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<td>7</td>
<td>11</td>
<td>12</td>
<td>1</td>
<td>50</td>
</tr>
</tbody>
</table>

Table 5.2: Participant Results - Iteration Two
5.5 Iteration Three

During the third iteration the online learning resource was not tested using participants but was tested on several mobile devices to ensure that it was fully functional for mobile users. There were several problems with the functionality of the online learning resource which concerned the layout of several steps and the use and positioning of videos.

5.5.1 Video

After testing the video on several mobile devices, it was noticed that the videos did not fit onto the screen correctly, which is shown in Figure 5.6a. Therefore it was decided to change the video and research for videos which have been implemented using bootstrap in order to ensure that the video would amend to fit a mobile device screen. An open source HTML5 video player was found on videojs [7] which fixed the cross-browser inconsistencies and added additional features such as fullscreen and subtitles. The result of the new video player is shown in Figure 5.6b

![Figure 5.6: Video Layout on a Mobile Device](image)

5.5.2 Mobile Layout

To ensure that the website would be compatible across all mobile devices (see Section 2.9.2) the third iteration tested the online learning resource on several mobile devices and it was noted that when the screen size width was reduced to below 992 pixels, the images for Step 2 and Step 4 for each lesson

45
moved above the title which is shown in Figure 5.7a. To ensure that the original image is always positioned below the text, an additional image was added below the text for both step 2 and step 4. CSS code was written so that when the screen size was greater than 992 pixels wide the original image was shown and the additional image was hidden, and vice-versa when the screen size was less than 992 pixels. The result of the additional CSS is shown in Figure 5.7b.

![Figure 5.7: Mobile Layout](image)

(a) Iteration 2  
(b) Iteration 3

5.6 Conclusion

The feedback from the student questionnaires identified that the videos were especially useful when explaining how to delete a code block from the script area. Students found it a lot easier to understand how to delete a block by viewing it in a video than reading how to do it and having one image to view.

The teachers identified that the submission page would be extremely useful in helping them to identify which students were either struggling with certain aspects of programming and for identifying which students required extra work in order to challenge them. One teacher suggested that they would set up a sub folder within their school email account which would automatically direct emails of a certain subject criteria straight into that specific folder.

The ideas created from the feedback were used to add, amend and re-design the website at each iteration to develop a strong final product.
Chapter 6

Evaluation

This chapter aims to evaluate and review if the project aims, objectives and minimum requirements have been achieved over the course of the project. The evaluation criteria identified in chapter one, see section 1.5 will be used to determine the success of the online learning resource. The purpose of the evaluation is to assess the success of achieving the learning objectives identified in Chapter 4, section 4.3 which outlines the use of a user study for the evaluation of the final iteration. The evaluation chapter will provide details of the final user study which allowed teachers and students to investigate the learning resource’s design, functionality, assessment criteria and provide feedback and recommendations for future improvements. The evaluation chapter also ensures that the code used within the resource is valid and that the resource achieved a AA level of compliance.

6.1 User Study

To evaluate the online learning resource, it was once again decided to conduct a user study. The user study consisted of six students and four teachers. The students were asked to complete a lesson within their Key Stage and complete a student questionnaire. The teachers were asked to browse the resource for twenty minutes and complete a teacher evaluation questionnaire.

6.1.1 Participants

The user study consisted of six students ages 8 – 16, five of whom had previously participated in either the first or the second iteration. Four teachers who teach in both primary and secondary school were also recruited to evaluate the website on its design, functionality and assessment criteria.
6.1.2 Method

Each student completed at least one lesson within their particular Key Stage within a 50 minute time period. Once the lesson was completed or the 50 minute time period was up, they were asked to complete the student questionnaire. The four participating teachers were asked to review the website for twenty minutes and then complete the teacher questionnaire. A template of the student and teacher questionnaires are available in appendix J.

6.2 Results

This section discusses the results of the data collected from the final evaluation completed by the six participants.

6.2.1 Time Taken to Complete Steps

Table 6.1 shows the time taken in minutes for each participant to complete the individual steps within a particular lesson. Participant five did not have time to complete step four and five and therefore there is no time value for these steps. Five out of the six participants completed more than one lesson. This was because they wanted to complete making a game so carried on through the Key Stage.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Key Stage</th>
<th>Lesson</th>
<th>Step 1</th>
<th>Step 2</th>
<th>Step 3</th>
<th>Step 4</th>
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<td>5</td>
<td>47</td>
</tr>
<tr>
<td>Participant 5</td>
<td>Key Stage 4</td>
<td>Lesson 1</td>
<td>7</td>
<td>14</td>
<td>5</td>
<td>15</td>
<td>9</td>
<td>50</td>
</tr>
<tr>
<td>Participant 5</td>
<td>Key Stage 4</td>
<td>Lesson 2</td>
<td>25</td>
<td>15</td>
<td>10</td>
<td>N/A</td>
<td>N/A</td>
<td>50</td>
</tr>
<tr>
<td>Participant 6</td>
<td>Key Stage 4</td>
<td>Lesson 3</td>
<td>5</td>
<td>15</td>
<td>15</td>
<td>5</td>
<td>9</td>
<td>49</td>
</tr>
<tr>
<td>Participant 6</td>
<td>Key Stage 4</td>
<td>Lesson 4</td>
<td>17</td>
<td>10</td>
<td>7</td>
<td>10</td>
<td>5</td>
<td>49</td>
</tr>
</tbody>
</table>

Table 6.1: Student Participant Results - Final Evaluation
6.3 Recommendations and Evaluation

The final solution met all of the objectives and goals set out at the beginning of the project. Teachers and students were actively involved from the onset which provided continuous recommendations for improvements. An online learning resource was created which contained 5 lessons for each Key Stage and included an objective for each lesson. The resource included downloadable snippets of Scratch code which the students used to complete tasks and the resource included the addition of videos for tasks which were easier to understand, by viewing a video compared to reading text. The further enhancement was completed as a submission page was created, which allowed students to send their teachers an emails with their Scratch programs attached. A broad range of viewpoints were taken into account which ensured that the requirements of the project were met. The questions within both the teacher and student questionnaires were designed to help assess the objectives of the project and the answers gathered were analysed to evaluate the design, functionality and assessment criteria of the resource. As identified in the background reading chapter, there was two additional methods of evaluation identified; the validity and accessibility checker. These additional evaluation methods were conducted for all pages fo the website and the results are shown in section 6.3.6 and section ??.

6.3.1 Design

The design of the website was evaluated by both teachers and students during the final evaluation. The feedback provided by both the teachers and students on different aspects of the learning resource is shown below.

Student Evaluation

The fundamental part of the website was designing and implementing the tasks for the students to complete. The aim was for each lesson to take 50 minutes to complete with each step taking around 10 minutes. The results show that not all the steps took 10 minutes to complete, with many taking more than 15 minutes. There are many reasons as to why the students spent longer on certain task than expected and whilst observing each student three causes were identified. One cause that I observed was that the students did not have enough knowledge of Scratch to complete the lessons in the required time frame. As the students had only completed a lesson within their Key Stage, they did not have the background knowledge of Scratch required for the steps to be completed within the 10 minute time frame. This was demonstrated by participant 3 who started at Key Stage 3, lesson 1 and was confused as to what a loop was. If the participant had completed Key Stage 2 before they had started Key Stage 3, they would have had a greater understanding of Scratch and would have understood what a loop was at that point. A second cause identified was that the students did not understand the phrasing used within certain steps and therefore found it confusing and hard to understand what was being asked of them. This was demonstrated by three of the six participants who were completing lessons as different Key Stages and had to re-read their tasks several times before they understood what was required of
them. The final cause that I observed was that the students process information at different speeds and therefore some students completed the tasks quicker than others. This was identified as one teacher said “it is great that there are several lessons for the students to work through, as students work at different paces. One student may complete a lesson in 30 minutes and another student may complete the same lesson in 50 minutes”

The results from the student questionnaires, indicated that the students enjoyed the tasks set for them as all six participants circled either the green or yellow face for both question 4 and 5 of the student questionnaire, which is important for the online learning resources success. Question 6 and 7 of the questionnaire asks the students whether there was any particular steps within the lesson that they did not understand. If the student circled a particular step for question 6, they also circled “I didn’t have enough knowledge of scratch to complete the steps(s)” for question 7. None of the participants answered question 7 “I didn’t understand what I needed to do” which suggested that if the students started at the basics of the online learning resource they would have had enough knowledge of Scratch in order to complete the tasks at the later stages.

**Teacher Evaluation**

The results from the teacher questionnaire, stated that the design of the website was simple and easy to use as it was not cluttered with pictures and characters moving around the screen like other learning resources they had used. Questions one to three of the teachers final evaluation questionnaire, shown in Figure J, assesses the design of the website. All of the participants rated the design of the website either number one or two on the rating scale where a number one represented a well designed website and a number five represented a poorly designed website. All of the participants rated the appropriateness of the language used within the website as number two on the rating scale where a number one represented very appropriate language used and number five represented not very appropriate language used. For question three of the teacher questionnaire all of the participants stated that there was a good amount of material within the website and they felt the website achieved its aims well.

**6.3.2 Functionality**

The functionality of the website was evaluated by observing the students during the completion of their activities during the final evaluation and the teacher’s feedback on the functionality of the website through the final teacher evaluation questionnaire.

**Student Evaluation**

All six of the students used the images attached to each step to help them identify which blocks of code were required for them to complete the activities. This was demonstrated as two of the six participants asked for confirmation that the image showed the blocks they needed.

**Teacher Evaluation**
The feedback from the teachers identified that the videos were extremely useful for students especially when the students were asked to duplicate the paddle in Key Stage 2, lesson 3. One teacher stated that the videos were a great addition to the resource for simple tasks, and were an appropriate length, as videos which are too long get paused half way though as the students find it boring. The results from the teacher questionnaire identified that the downloadable Scratch snippets were useful for the students as all of the teachers rated the downloadable snippets of Scratch as number one on the rating scale where number one represented very useful and a number 5 represented not useful. One teacher suggested that more downloadable snippets of scratch should be available in Key Stage 2 as students are able to download Step 4 in lesson 3 but do not have any other snippets of scratch to download until after they have finished building their ping-pong game.

6.3.3 Assessment Criteria

The submission page was created as a form of assessment for the online learning resource, as teachers would be able to view what each student had completed each lesson. The feedback from the teachers was provided in the final teacher evaluation questionnaire. The students were asked to submit their work by typing in their own email address or their parent’s email address and attaching their completed program.

Student Evaluation

All of the students were able to enter all of the required information for the submission form easily without any of the students asking for help. Three of the participants could not find the files they required for the submission but once with a little bit of help they were able to locate the file.

Teacher Evaluation

The feedback from the teachers was positive as they all stated that the submission page would be easy to use and would allow them to view each students work individually. Question seven to nine and question eleven of the teacher’s final evaluation questionnaire assess the assessment criteria of the website. All of the teachers stated that the submission page was useful and ‘easy to use’ which would therefore not evoke any problems. Question eleven, “How would you measure to see if the learning objective has been met within each Key Stage?” was answered very differently by each teacher. One of the teachers stated that for Key Stage two, “checking the classes work constantly throughout would mean it is very easy to check if the children have achieved the learning objectives.” Where as one teacher suggested that as well as a student submitting their completed files, they could also submit screenshots of their work. This would enable teachers to confirm if the student has completed the task correctly by viewing the screen shot. This suggestion was reinforced as other teachers thought checking each file could be extremely time consuming whereas viewing images would be less so.
6.3.4 Additional Feedback

All of the teachers provided positive feedback for the online learning resource and they all stated that they would use the resource as an alternative form of teaching programming at schools in the future. A Key Stage 2 teacher suggested that they would be interested in using the online learning resource in the future. They also emphasized that they would only use it for year 5 & 6 students as years 3 & 4 would find it difficult to understand.

Another teacher suggested that a section for the teachers/instructors would be beneficial as it could explain why the resource has been created, how long each task should take and could also include the answers to the tasks. As the resource is available for anyone to use without any form of password protection, it would be difficult to find a place within the website where the answers could be located which was not obvious for the students to find. The teacher suggested that within teachers/instructors page, there could be a link to a PDF document which contains the answers to the tasks. As the students would need to find the link within the PDF, the teacher believed that if a student had gone to that much trouble to find the answers, then they deserve to find them. The same teacher suggested that using screenshots as a form of assessment would be beneficial as it would quicker to view a screenshot compared to opening several programs for one student and suggested that in addition to the completed programs in the answer section, screenshots of the correct code could be included.

6.3.5 Feedback From Supervisor and Assessor

Feedback from my supervisor suggested that changing the names, ‘Key Stage 2’, ‘Key Stage 3’ and ‘Key Stage 4’ to ‘Starter’, ‘Intermediate’ and ‘Advanced’ would be advantageous. It would benefit students who are in both Key Stage 3 & 4 and have never used Scratch before as they would not feel like they are doing a lesson for someone younger than them. Feedback from my assessor in my final progress meeting suggested that it would also be beneficial for students to be able track their progress when using the learning resource. From this suggestion, it was decided that for future work a login page can be created where students will be able to sign in to their individual accounts and check their progress as they complete each activity.

6.3.6 Validation

As identified in section 2.9, it is good practice to validate the code created within a website to ensure that errors have been removed. It was decided that validating the code was an additional form of evaluation for the online learning resource. Every page within the online learning resource was validated using www.validator.w3.org/. There were pages which received errors on the first attempt of using the validator, but these were all corrected and a report for each page was produced. The index page validation is available in appendix L.
6.3.7 Accessibility

As identified in section 2.10, the Web Content Accessibility Guidelines 2.0 are a set of benchmarks and guidelines used by developers when producing accessible content. It was decided in section 2.10.3, that ensuring that the online learning resource achieved a AA level of conformance was an additional form of evaluation for the resource. Each page within the online learning resource was tested using A-Checker [2]. The results showed that all of the pages within the online learning resource achieved a AA level of conformance and the index page accessibility review report from A-Checker is shown in appendix K.

6.4 Project Schedule

The project schedule was revised during the project as the original schedule relied on testing the resource on students from local schools. Unfortunately due to teachers not responding to emails this was not possible and other participants needed to be recruited. The schedule created at the start of the project was realistic and was used throughout the project, with minor changes due to unforeseen circumstances.

6.5 The Future

The project has been very successful throughout and has received excellent feedback form all of the teachers and students who used it. As a result, the outreach team for the University of Leeds want to make the online learning resource available within their STEM website which can be found at, www.stem.leeds.ac.uk. The outreach team are planning to provide some temporary work over the summer in order to implement the resource and add additional features so that it can be an automated learning tool. The additional features are described in more detail in Chapter 7.

6.6 Summary

Feedback from the teachers and students was used to make some small final amendments to the online learning resource, the larger amendments will be used as ideas for the future of the online learning resource. The small amendments completed below;

- The names, ‘Key Stage 2’, ‘Key Stage 3’ and ‘Key Stage 4’ were changed to ‘Starter’, ‘Intermediate’ and ‘Advanced’ as well as changing the name ‘Lessons’ to ‘Activities’.
- An additional page for teachers/instructors was created which explained to teachers/instructors why the resource is created and what activities are appropriate for different Key Stages.
• Within the teachers/instructors page a link to a PDF was enclosed, which housed the answer programs and screenshots. Each screenshot includes a watermark, which ensures that the students could not save the screenshot and use it as their own answer when submitting their work to their teachers.

Images of activity 1 for each level, are shown in appendix M. The other feedback from the teachers and students has been used as future possibilities for the project and are explained in Chapter 7.

6.7 Conclusion

Overall, the author considers this project to have been a success and to have been completed to a high quality. The evaluation has shown that both the teachers and students enjoyed the activities within the online learning resource and all of the teachers stated that they would use the resource in the future. However the online learning resource is by no means complete and can be continuously improved in the future by adding additional activities. The ideas for the future work for the online learning resource are shown in Chapter 7.
Chapter 7

Future Work

Feedback from my assessor during the final progress meeting suggested that introducing a way for students to track their own progress within the online learning resource would be advantageous. Due to the time constraint of the project it was not possible to create and implement the login and registration page, however time has been spent researching and designing the future possibility of a sign in page. This section will explain the thought process into designing and constructing this addition to the online learning resource.

7.1 Existing Online learning resources

To acquire a greater understanding of what is required for a login page, research was conducted into existing learning resource which have a login page. After asking several teachers which online learning resources they currently use within the classroom, www.mathletics.co.uk, www.espresso.co.uk and www.educationcity.com were recommended as resources which have been successful with student engagement. It was decided to ask teachers which online learning resources have been successful with student engagement, as it is essential for students to enjoy using the resource. A online learning resource may be designed and implemented extremely well but if students do not engage with it and do not like using it, it is useless resource.

www.mathletics.co.uk [1] is a successful mathematics online learning resource used by teachers, students and more than 10,000 schools worldwide. Mathletics [1] allows students to login to their individual account and complete tasks to achieve points and medals. The students progress within the online resource can be tracked by their teachers and parents and the student’s individual and class scores are also entered into “Mathletics Hall of Fame”. Once a student signs into their account
they are able to see what topics they have completed, started and not attempted within certain topic areas. When the student wants to start a new activity they are able to choose a level most suitable to them for that particular topic; ‘Easier’, ‘Core’ and ‘Harder’ and then choose an activity based on the difficulty they have chosen. Each activity has a progress bar which is split into 4 different colours to notify the student of their progress so far. If it is coloured blue = ‘unattempted’, red = achieved ‘less than 50%’, silver = achieved ‘between 50% and 84%’ and gold = achieved ‘more than 85%’. The students also receive points for completing activities and the points are broken down into daily and weekly scores so that students are able to see their achievements and how many additional points they require to receive the next award.

![Student’s Account within Mathletics](image)

**Figure 7.1: Student’s Account within Mathletics**

www.espresso.co.uk [15] is an award winning digital teaching and learning service for primary school students and has been used across the UK for the past 16 years. www.espresso.co.uk caters for all subject areas and can only be purchased by schools which therefore requires students to login. Most recently it has introduced ‘espresso coding’ which is a new service which teaches students to code and make their own applications.

www.educationcity.com [14] is a trusted interactive learning resource used by over 15,000 schools in the UK and worldwide. The resource also has a progress board for the student where they can view their “success” within all of the different subject areas at once as shown in Figure 7.2.
7.1.1 Summary

After researching existing online learning resources it was evident that resources which allow students to login into their individual accounts not only allows students to track their own progress but also encourages them to complete more activities and advance to higher levels, as they have the potential of winning awards. The opportunity for students to login into their individual accounts allows teachers and parents to track the students progress and allows them to assign specific activities for the student to complete before they are able to access other features of the learning resource. These are just a few advantages of introducing the login feature for www.kinectwithscratch.co.uk, and the research has generated many ideas on how the login feature can be applied to the online learning resource created.

7.2 Design

The first step for the design and creation of the sign in page is to create a prototype for the front end for both the registration and login window using HTML and this available in appendix M. A first time user will be required to register to use the online learning resource and will need to input their forename, surname, school name, password and their email address which will be stored within a database. A unique username will be generated and emailed to each user along with password confirmation. The user will use their assigned username and password to enter the online learning resource. In order to identify that a user is authorised, the combination of the username and password are checked against the database and if the combination entered is correct, a session variable is set and the user is redirected to the protected content for their particular username. Once the user has logged into their account, they will be directed to their individual homepage and a low-fidelity prototype of the users individual account homepage has been constructed and is shown in Figure 7.3. Within their
account the student will be able to view the Key Stages and lessons that are available to them and replace with their progress on each activity; either ‘Completed’, ‘Work in Progress’ or ‘Not Started’.

7.2.1 Activities

In the future the activities could be expanded on so that there is more than five lessons for each Key Stage. The feedback from the teachers suggested that games should take no longer than three lessons to complete as students will become bored. Taking the resource forward, a key aim should be to continue to create new and interesting games as students will be able to complete the current activities within the resource within a short period of time.

7.3 Functionality

To improve the functionality of the online learning resource, it would be beneficial to improve the accessibility from AA to AAA standard. The resource is currently at a AA standard and to achieve a AAA standard the resource would need to look at becoming more accessible for visually impaired
users. The introduction of audio commentary for the videos and making the resource more friendly for screen readers would allow the resource to be more accessible.

### 7.3.1 Scoring System

The introduction of a scoring system, where students have the ability to gain points for every step they complete, with the potential of achieving 250 points per activity. The points would be entered into a leader board, which would be updated every day to acknowledge which user has both gained the most points that day, that week and overall. Figure 7.4 shows a low-fidelity prototype of what the leader board would look like.

![Prototype for Leader Board](image)

### 7.4 Assessment Criteria

The online learning resource currently allows students to attach their programs to the submission form and send them to their teachers. An additional assessment criteria could be introduced in the future where students will be able to gain points for every step they complete. These points can then be entered into the leader board shown in figure 7.4. Another additional assessment criteria could
be introduced in the form of a simple test. These tests could be introduced after each activity is completed, where 5 question with multiple choice answers can earn the student an extra 50 points.

7.5 Conclusion

In conclusion this project has created an online learning resource which enables students to learn the basic principles of programming in an interactive way. The activities within the online learning resource enable the students to achieve the targets set out in the new National Curriculum for Computing. This project identified the future possibilities of the online learning resource, demonstrating that it has potential and could be used by teachers and student across the UK. Some additional time will be required to implement the changes identified within this chapter, which will ensure that the online learning resource is efficient in teaching programming to students within Key Stages 2 – 4 as an automated learning tool.
Bibliography


Appendix A

Personal Reflection

The Final Year Project is by far the hardest piece of work I have completed to date. It was been extremely challenging and has tested my patience on more than one occasion. There has certainly been many highs and lows throughout the project and this section of the report will highlight my experience in completing the project and the advice I would give to a future student starting their project.

The first piece of advice I would give to a future student is to start the project you have chosen as soon as you can. Once your project has been confirmed, start the background reading into the project area and establish which route you want to take the project in. I underestimated how long the background reading would take and therefore had to re-visit it before I started to design the online learning resource. Therefore I would advise future students to start to read around the project area as soon as they can.

The second piece of advice I would give to a future student is to make sure that you choose a project which is of interest to you. You will be working on this project everyday for four months and will therefore want to enjoy what you are working on. As programming is not my strongest subject area and neither my favorite, I decided that I wanted to complete a project which made programming more interesting and enjoyable for students from a young age.

The third piece of advice I would give to a future student is to make sure that as soon as your project has been confirmed, think about all the participants you will require for user studies, user testing and evaluation. With my project I required both teachers and students to evaluate the online learning resource during several iterations. The teachers were contacted a couple of weeks after the project commenced, but unfortunately when they were contacted for the evaluation, no response was provided. This resulted in myself recruiting participants for the initial user study and for the
evaluations. Therefore I would advise students to confirm participants as soon as possible so that you can complete testing as planned. If a future student is to complete a project in a similar topic area, I would advise them to organise testing with several teachers to ensure that they have enough participants.

My final piece of advice I would give to a future student is to not underestimate how long a report of this size takes to write, construct and proof read. I had never written a report of this size before and did not realise how long it takes to insert images and tables in the correct places and proof read. My advice to a student would be, complete your report at least a week in advance and then you have time to correct any errors and proof read your report several times.

Summary of the Advice for future Final Year Project Students

- Start your project as soon as you are assigned your project title and do not wait until after you have completed your exams. Start some background reading into the project area and construct a project plan ready for when you officially commence your project.

- Select a project which interests you.

- As soon as the you start your project, contact everyone you will need to take part in user studies, testing and evaluation.

- Do not underestimate how long a report takes to write up.

To summarise my personal reflection, I believe that the project went well and according to plan. There were several challenges to overcome throughout the project but with perseverance I was able to rectify them quickly and continue with the project as planned. I have enjoyed working on this project and I am very pleased that I chose to work on a project which could be benefit students in the future and potentially encourage a greater number of students to study computing at GSCE and A-Level and then Information Technology or Computer Science at University.
Appendix B

Record of External Materials Used

This Appendix lists the materials which were used within the project that were not created by the author.

- Twitter Bootstrap CSS Framework for the layout of each webpage.
- Scratch.mit.edu website for the user study.
- Kinect2scratch software for connecting Scratch with the Kinect, and can be found at http://scratch.saorog.com/. Created by Stephen Howell.
Appendix C

How Ethical Issues were Dealt With

This section discusses the ethical issues which had to be considered during this project.

To ensure no ethical issues were broken, each participant was provided with a detailed information sheet which provided them with a thorough background into the project and the aim of the project. The information sheet explained why they have been chosen and that any results, feedback and opinions gathering would remain confidential and anonymous. It also explained the results gathered in the testing will be published in a report for the undergraduate module COMP3860 research project and that they could withdraw from the testing at any time. All of the participants completed and signed the consent forms, so that they could take part within the testing.

To ensure no ethical issues were broken, permission was approved from Stephen Howell to use the Kinect2scratch software within the online learning resource.
Appendix D

Site Map

Figure D.1: Site Map of Website
Appendix E

Low Fidelity Prototypes

Figure E.1: Low Fidelity Prototype of the Websites Index Page
Each lesson will have 4 steps to work through. Each step will have an image that will help with completing the step.

The buttons at the top will have drop-down menus that will allow the user to move onto the next lesson by selecting 'Key Step 2 - Lesson 2.'

Figure E.2: Low Fidelity Prototype of Website Lesson 1 Page
Appendix F

Teacher Information Sheet

Teacher Project Evaluation Sheet

Project Title: Creating an innovative learning resource for teaching Tolkien using the School to Key Stage 2 - 4.

You are being invited to take part in a student project. Before you decide, it is important for you to understand the aims of the project and what participation will involve. Please take time to read the following information carefully and discuss it with others of your choice. Ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for reading this.

Project Aim: The aim of the project is to create an interactive learning resource which teachers and students can use to enhance and develop their understanding of programming, with the help of Tolkien and the Hobbit. The duration of the project is 12 weeks.

Why have I been chosen? You have been chosen to take part in the project as you are teacher teaching at least equivalent to Key Stage 2, 3 or 4 which is relevant to this project.

Do I have to take part? It is up to you to decide whether or not to take part. If you decide to take part, you will be given this information sheet so keep it (or ask to sign a copy) and you can still withdraw at any time. You do not have to give a reason.

What will happen if I take part? As a user, you will be asked to complete the online learning resource for 10 – 15 minutes and then you will be required to complete a questionnaire. All of the equipment required for the testing, will be provided by the student society. Any results and feedback gathered from the questionnaire may be included in the final project report.

Will my taking part in this project be kept confidential? Yes, any results, feedback or opinions gathered from the testing, answers will remain confidential and anonymous to the final project report.

What type of information will be sought from me and why is the collection of this information relevant for achieving the project’s objectives? The information that is collected will help to answer the question, to your opinion, of how effective this teaching aid is. This information is important in achieving the project’s objectives as it is the method being used to measure the success of the online learning resource.

What will happen to the results of the project? The results of this project will be published in a report to be submitted for assessment at the end of the undergraduate module COMP0412 Research Project in the School of Computing at the University of Leeds.

Contact for further information: leslie@ic.literature.org.uk

If you decide to participate in this project, you will be given a copy of this information sheet and a signed consent form to keep. Thank you very much for taking the time to read this information sheet.

Figure F.1: Teacher Information Sheet
Appendix G

Student Information Sheet

Figure G.1: Student Information Sheet
Appendix H

Consent Form

Figure H.1: Consent Form
Appendix I

Teacher Questionnaire

Final Evaluation Questionnaire

Please take 20 minutes to look through the online learning resource at www.match2match.co.uk and answer the 14 questions below.

1. How would you rate the design of the website? (1 = well designed; 5 = poorly designed)
   1 2 3 4 5

2. How do you rate the appropriateness of the language used? (1 = very appropriate; 5 = not very appropriate)
   1 2 3 4 5

3. How would you rate the amount of material for each lesson?
   Not enough material  A good amount of material  Too much material

4. Would the exercises be interesting for the students?

5. Is there any obvious places within the lessons which you think the students would get bored or find difficult?

6. How useful do you think the downloadable snippets of scratch are? (1 = very useful; 5 = not useful)
   1 2 3 4 5

7. How useful do you think the submission page is? (1 = very useful; 5 = not useful)
   1 2 3 4 5

8. Is there anything you would do differently within the submission page?

9. How would you use the submission page to evaluate the learning objectives?

10. What do you think of the resource as an alternative form of teaching programming at school?

Figure I.1: Page 1 of Teachers Questionnaire
11. How would you measure to see if the learning objective has been met within each Key Stage?

12. Would you be interested in using the online learning resource in the future?

13. Would you find it useful to have the answers to each task, accessible within the online learning resource?

14. Do you think there is anything additional which is missing from the online learning resource?
Appendix J

Student Questionnaire

Questionnaire

Please can you answer the questions below:

1. What Key Stage did you do? (Please circle your answer)
   - Key Stage 1
   - Key Stage 2
   - Key Stage 3
   - Key Stage 4

2. Which lesson(s) did you start? (Please circle your answer(s))
   - Lesson 1
   - Lesson 2
   - Lesson 3
   - Lesson 4
   - Lesson 5

3. Which step(s) did you complete? (Please circle your answer(s))
   - Step 1
   - Step 2
   - Step 3
   - Step 4
   - Step 5

Please can you complete the questions below by circling the face which is most appropriate.

4. Did you enjoy the task(s) which you were set?
   - Smiley face
   - Neutral face
   - Sad face

5. Was it easy to understand the steps?
   - Smiley face
   - Neutral face
   - Sad face

6. Which step(s) did you find difficult, if any? (Please circle your answer(s))
   - Step 1
   - Step 2
   - Step 3
   - Step 4
   - Step 5
   - None

7. If you did find the step(s) difficult, why did you find them difficult? (Please circle your answer(s))
   - I didn’t understand what I needed to do
   - I didn’t have enough knowledge of scratch to complete the step(s)
   - Other

Figure J.1: Page 1 of Student Questionnaire
Observation

What Key Steps and Lesson completed?

How long did it take for each step to be completed?

Step 1 =

Step 2 =

Step 3 =

Step 4 =

Step 5 =

Did the student require any help?

____________________________________________

____________________________________________

____________________________________________

Figure J.2: Page 2 of Student Questionnaire
Appendix K

Accessibility Checker

Figure K.1: Accessibility Checker
Appendix L

Validator

Figure L.1: W3C Validator
Appendix M

Online Learning Resource

This appendix shows images of the first activity page for each level.

Figure M.1: Index Page

Figure M.2: The Basics - Activity 1 Page
Figure M.3: Starter - Activity 1 Page

Figure M.4: Intermediate - Activity 1 Page

Figure M.5: Advanced - Activity 1 Page