

Final Submission

by Andrew Cooper

FILE	4075_ANDREW_COOPER_FINAL_SUBMISSION_50131_1881867524.DOCX (1.33M)		
TIME SUBMITTED	03-MAY-2019 05:45PM (UTC+0100)	WORD COUNT	5060
SUBMISSION ID	106274437	CHARACTER COUNT	27812

This document will contain the project proposal that has been put forward by student 1704746. The author will contain background information, research methods and resources required for the project to be a success.

Project Proposal

Design and Implementation of
an Augmented Reality
Application that can be used in
acadmia.

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1. Background Information to the Proposed Project

1.1 Introduction

In this project proposal, the author will discuss the pros and cons of using augmented reality in academia as a tool to enhance students learning experience, as well as review software available to use to implement the project. In order to achieve this aim, an evaluation and comparison of current research on augmented reality and its application in academia will be performed. The research will also analyse various research and development methods in order to determine an appropriate technique that will suit the project proposed. To reduce the risk of potential failure, a list of risks, limitations, legal and ethical issues will be produced, understanding the potential challenges which might occur before starting the project allows for precautions to be implemented to mitigate the risks. The author has created a Gantt chart to effectively plan and manage tasks to ensure objective targets are being met in a timely fashion, as well as identifying a list of hardware and software required to successfully complete the project.

1.2 Aims and Objectives

The aim of the project is to develop an AR application that can be used in academia, which could enhance a student's learning experience.

To ensure that the project is completed as a minimum viable product, the list of objectives must be completed to a high standard.

1. Study augmented reality applications and identify how they are currently being used in academia.
2. Examine any current principles and guidelines for making an AR application.
3. Design and implement an augmented reality application.
4. Conduct primary research to identify users experience using the application.
5. Evaluate results collected from user feedback and suggest changes which can improve the application for future users.

The author of this project proposal has specifically chosen to design and implement an AR application as well as investigating whether the use of augmented reality application can be used in an educational environment to enhance the quality of learning with the intention of helping students obtain a better understanding after using the augmented reality application.

1.3 Project Title

The title that the author will be working to is "Is Augmented Reality a Viable Medium to Aide Students Learning?".

1.4 Background Information on Augmented Reality

Augmented reality is a field of study that has grown in massive popularity since the 1990s, when the term augmented reality was created by researcher Tom Caudell at the Boeing company [1]. The term was coined to describe the blend of virtual graphics on the physical world [2]. In *Augmented A Practical Guide*, augmented reality ambition is "to create a sensation that virtual objects are present in the real world" [3].

Although the name wasn't created until the 90s, the concept was first implemented in 1968 by Harvard associate professor Ivan Sutherland with student, Bob Sproull [1] [3]. *The Sword of Damocles* was a head-mounted device which hung from the ceiling and gives the user the illusion they were in an alternate reality [4]. Although the idea of the user being immersed in an environment separate to

the physical world is known as virtual reality, this idea was a massive leap forward to the design and implementation of augmented reality.

In recent years, augmented reality has become a part of people's daily life around the world with extremely popular app's like Pokémon Go and the Ikea application, which allows users interact with virtual objects on a mobile or tablet device. These are just two examples of the uses of augmented reality, the list and possibilities that this technology has to offer is endless and can be used in a vast majority of industries, from entertainment to education, healthcare through to architecture.

Augmented reality learning is not an unthought of concept, this idea has been executed in many different subject areas and age ranges, from primary school teaching to university studies and popularity of this method of teaching and learning is every growing [5].

1.5 Available Software

Developing software, such as the Apple's ARKit is a development platform that provides developers with the required tools to develop augmented experience for iPad and iPhone. An updated version of ARKit, ARKit 2, allows users to share and manipulate the augmented objects and return to the application at a later date to the same state [6]. Using a development platform in a project can save the developer a huge amount of time as it performs "a lot of the heavy lifting", as said by Samuel Axon, the senior reviews editor at Ars Technica [7].

Another tool that will be used in conjunction with ARKit 2 is a 3D game engine as this will be used to create 3D models and rendering them. There are many game engines that could be utilised to create this project, however, the two game engines the author has decided to evaluate Unity and Scene Kit.

1.5.1 Unity

Unity is a game engine that has a strong focus on 3D content and is extremely popular with hobbyist and professionals. Due to its focus on 3D graphics and extensive cross platform compatibility it is also an extremely popular choice for AR applications.

1.5.2 SceneKit

SceneKit is Apple's version of a 3D graphics framework with a special focus on iOS development.

1.5.3 Comparison

To choose the best option for the development of the project, the creator must weigh the pros and cons of each option.

Unity	
Pros	Cons
Ease of use when debugging due to its built in IDE.	Larger file sizes due to having a import a full physics engine.
Resources and documentation available.	Power consumption can be unresourceful.
Speed of development across multiple platforms.	
High frame rates	
Asset store availability.	

SceneKit	
Pros	Cons
Better for applications with less objects and particles.	Assets can be more expensive.
Vast number of plug-ins and libraries supported.	Less documentation readily available.
	Currently unable to develop for products not owned by Apple.

1.5.4 Software of Choice

After considering the pros and cons of each option, the game engine that will be used is Unity because documentation and tutorials are more available, ease of debugging due to the IDE and the assets and environment can be used to make the application cross-platform in the future.

There are two main methods of implementing augmented reality into an application which determines how the user interacts with virtual layer, these are location based, and vision based.

1.5.5 Location Based

Location based AR takes the users physical location into consideration. The application requires access to the device's GPS which can then display relevant information to the user regarding their surrounds, including but not limited to: eateries, museums and other local amenities.

1.5.6 Fixed Vision

This method of AR predominantly uses a device's camera, display and processor to add an augmented layer to what the camera is capturing. This method of augmentation is extremely popular and was used in applications such as Pokémon Go.

1.6 Project Aim

The author will design and implement the project with the purpose of understanding if using augmented reality can better students understanding of a subject area. The project will be created for iOS devices with the aim of extending the application to allow users to "share" an environment. When creating the application, the author has decided to use the fixed-vision approach as it will allow the users to use the application to its full potential anywhere, at any time.

Once the project has been implemented, the author aims to test the product within University of Wales Trinity Saint David and a local primary and secondary school if time allows as this will allow for an in-depth evaluation of the project on various demographic factors such as age, sex, region and other relevant information.

1.6.1 Expected Outcome

Upon completion of the project, the author expects that the AR application will be designed and deployed on a test device to allow users to test the product. Test data will be analysed to determine whether augmented is a viable pedagogical tool.

To support the application and assist the potential users, a brief user guide will be created to explain how the application should be used properly.

When the AR application has been tested, the author will submit a detailed report; including a user guide, software specification, user feedback and suggestions that will enhance the users experience in future iterations of the project.

1.7 Literature Review

Engagement with current literature allows the author to obtain further understanding of what other researchers have found when they research the same or similar projects.

There are many papers that have been produced that both support and reject the premise of augmented reality in an academic setting.

In a conference paper, titled The Exploration of Augmented Reality Technology Applied in Colleges' Experimental Teaching, it was stated that although AR as a pedagogical tool has benefits, it does also come with misdemeanours, "lots of university experimental teaching workers have not been aware of the superiority of AR technology yet" [8]. This suggests that although the technology is viable and available, the promotion of the application is yet to be perfected.

Other papers have suggested that the technology could become a distraction for students as they may be in awe of this brand new way of learning and would appreciate the concept of the application as apposed to the content available, "the novelty of the technology may detract from the learning experience (e.g. students focussing on shiny new devices rather than their learning objectives)" [9]. It is important to note that this paper was written in 2012 when augmented reality wasn't being used in daily life. For this reason, it is believed that this would not be an issue when developing the project.

A paper that conflicts the idea that students will be more distracted by the use of augmented reality is *Development and behavioural pattern analysis of a mobile guide system with augmented reality for painting appreciation instruction in an art museum*. An experiment in a museum was conducted to see how different methods of museums tours to see how people reacted. The study found that people who toured the museum using the augmented reality method were "more proactive" [10].

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1.8 Study Justification

Augmented reality as a pedagogical tool was chosen as a project to study and implement as this area of study has grown in massive popularity in the recent years. The possibilities within this field are endless and in future years, could be the way lessons are taught in classes. Furthermore, various studies found people who use AR tend to have greater motivation, performed better academically and a better understanding of the topic [11]. Another reason why the author chose this subject is because it is within the relevant field that he wishes to pursue as a career following the completion studies at University of Wales Trinity Saint David.

However, an aspect of the project that could be detrimental to the design and development of this project is the healthcare of users, "according to this study, there is an association between smartphone use and ocular pain and headache" [12].

1.9 Conclusion

Following an overview to the subject, the author has come to the conclusion that augmented reality can be a valuable asset in an academic setting to help support students learning experience providing utilisation of the software is monitored and being used for its intended purpose. Furthermore, development of the application will be undertaken in Unity due to the ease of use and potential cross-platform extendibility. Lastly, it has been deciphered that the style of augmentation for the application will be fixed-vision as this will allow effective use of the software at all times.

In the next section, the author will discuss research and development methods in order to evaluate which approach would be the best suited for the augmented reality application that will be created for the project.

2. Research and Development Methods

2.1 Introduction

In this section the author will analyse the research methodology and the development strategy that will be followed. To ensure that the project is carried out lawfully the author will conduct research to identify any legal and ethical issues that may arise when developing and testing the application whilst considering appropriate methods to overcome these potential hinderances.

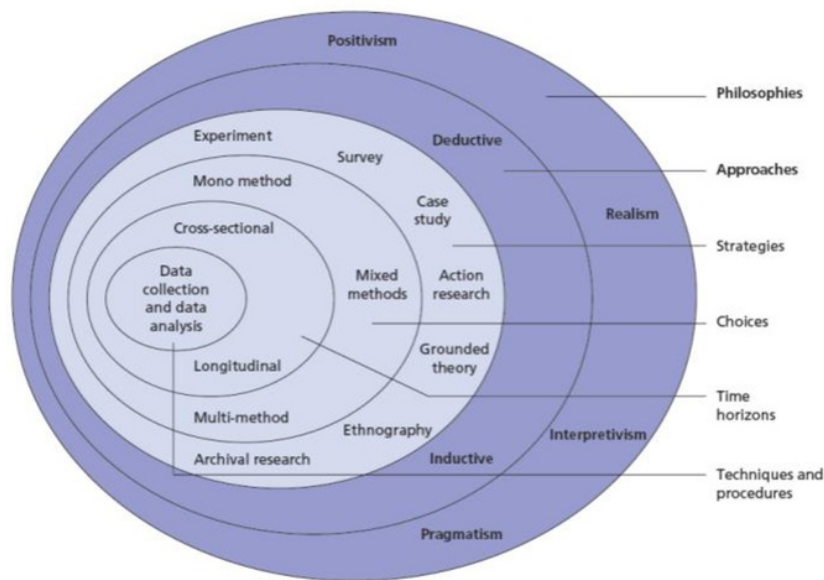


Figure 1: The Research Process "Onion" [13].

2.2 Philosophies

A philosophy is a methodology that that can be adopted to perform research in an area of study, it is important to note that there are many philosophies and choosing the correct one is imperative as some projects are suited better to certain philosophies.

There are two potential philosophies that could be used when researching the project, these being, positivism and phenomenology.

2.2.1 Positivism

Positivism is a research approach which prefers information gathered to be quantitative by conducting surveys, questionnaires and evaluating previous studies, as the researcher can have a high level of confidence in the results. However, to achieve data that is reliable it usually requires research to be performed on a large scale with a wide range of participants.

Although the positivism approach is excellent at collected raw, short, precise data it also means that peoples' opinions aren't accounted for. Furthermore, the idea of individualism is neglected as research tends to be analysed in the 'big picture'.

2.2.2 Phenomenology

Phenomenology approach aims to uncover peoples' opinions and experiences on a subject matter. Data obtained from this approach can be classified as qualitative and only requires a small data size. As the student wishes to obtain an understanding of overall students' performance when using the application and not just that of one student, this method would not fit best with the project aim.

2.3 Philosophy Approach Adopted for Research

Due to the nature of the project, an augmented application for academia, the best suited methodology to pursue is positivism. Primary data that the author has collected will be quantitative in large volumes, meaning that information gathered can be measured and can be seen as more trustworthy. Additionally, positivism will best enable the author to identify trends in overall students' performance as opposed to just the performance of an individual student. It is imperative to understand the impact of the application on students' performance and can be argued that the best approach for this is using factual data such as test results. Positivism will enable the author to effectively evaluate the relationship of the augmented reality application and students' academic performance and determine whether there is a correlation between the use of the application and students' understanding of a particular subject.

After choosing an appropriate philosophy, it is important that the author chooses an approach that will best suit that style of research which can be either inductive or deductive.

The inductive approach is when a researcher will collect relevant information on their topic and then analyse the data to find any trends and patterns that emerge. Once the data has been investigated, the researcher will then propose a theory. This approach takes a specific observation and then generalises what has been found.

The deductive approach requires the researcher to theorise before analysing the data. Once data has been gathered and studied; it will verify if the initial hypothesis was correct. Deductive reasoning is the opposite of inductive in a sense that a theory is suggested then after data is examined will then lead to a more specific outcome.

The author has chosen to implement the inductive approach. Research has shown the concept of augmented reality as an educational tool has already been established, proving there is a market for the product. Hence, the author is not attempting to prove his own theory but instead evaluating data to understand the application of augmented reality in education, how this technology can help students and the implications of using augmented reality to enhance students' learning experience. Previous studies will enable the author to determine appropriate requirements in order to best enhance students' performance and learning experience.

2.4 Strategies

The strategy that has been chosen to implement this project is software development paired with document review and case studies as these are strategies most commonly used in projects that involve development.

Software development strategy is the process of developing software testing and evaluating to discover if the solution works as intended and then if necessary, analysing feedback to discover users'

opinions on the developed software. This method fits well with the project as the author will be creating an augmented reality application that can run on iOS devices.

Augmented reality as a pedagogical tool is an area that has seen rapid growth in research; this is beneficial for future study because documentation can be reviewed and analysed to get a greater understanding of the research that has been conducted and uncover potential gaps in research. Using the reviewed document, the author can also find potential issues that could arise during the implementation [15]. Documentation that has been composed by other researchers in the field. An advantage of using this strategy type in the developer's project is it could help strengthen the argument that the author is trying to convey. The document review will be written as a literature review where the author will compare and contrast research papers.

Case studies are a research based methodology which requires the researcher to investigate a singular or groups of people, this can become extremely time consuming and difficult to repeat any tests conducted. This strategy compliments the project because it requires data attained to be extremely detailed as this will be required to give an explanation as to what test is being implemented and what effect this had on the results.

2.5 Time Horizon

The time horizon of a project describes how long the tests will be implemented for, the two main areas that will be reviewed in this project will be cross-sectional and longitudinal. Both cross-sectional and longitudinal studies are observational, meaning the researcher will not manipulate the environment [16] or persuade participants to change their current routines.

A longitudinal study is where a researcher will collect data on a particular subject or subjects over a length of time which could go on for years. This method is beneficial if the project aim is to evaluate how people develop over a set amount of time.

Cross-sectional research is a much denser study as it will only take information from the current time, somewhat like a snap shot of the current information obtained meaning all previous (if any) research of the test subjects would be disregarded.

The time horizon that would best fit this project is longitudinal as it is important for the author to understand cause-and-effect relationships between students before and after using the AR application to identify improvements in performance. Additionally, the author will use variables such as user age to determine whether user experienced motivation and willingness to learn has improved after using the AR application and what implications these factors have on the project.

2.6 Data Collection

Data collection refers to how information will be gathered for each objective. For the project a mixed method approach will be used as a means of gathering data, meaning the data will be qualitative and quantitative. Using a mixture of both types of research allow the researcher to analyse numerical data (quantitative) as well as get an understanding of users opinions of the application (qualitative), which is extremely useful for suggesting further updates in later iterations of the application. It is important to note that data collected will focus prominently on quantitative data, as it is vital that the author obtains factual data on students' experience in using the application and how this experience correlate to overall performance in education. Qualitative data will be use more as a method to shed light on information the author may not have considered.

To identify whether the participants have found the application to be effective, the researcher will ask a series of short questions related to the subject area before and after use. The data received from these tests will reveal truly if users are getting the most out of the app’.

A questionnaire will be used to validate whether augmented reality is an effective method of learning and if there are any changes that could be implemented to make the improve the experience in future updates.

2.7 Risks and Limitations

When considering any project, it is important to analyse and produce a series of risks and limitations that may hinder the success of the project.

When developing an application for students we must be mindful of risks that may arise, these potential problems are:

- Not enough data collected to be able to make a conclusion if the theory was correct.
- Issues managing time effectively.
- Unable to complete application due to a gap in skills required.
- Not prioritising tasks effectively and consequently failing to add vital components due to excessive time spent implementing unimportant application features.

2.7.1 Ethical Issues

Although it is unlikely, an ethical issue that may occur is accident, injury or death to users after the application has been implemented and released. Augmented reality game, Pokémon Go caused a huge rise in accidents after being released due to people playing the game whilst driving and or becoming distracted [17]. It has also been discussed that as AR technologies advance it could cause certain types of users to confused augmented features with physical, “confusion amongst vulnerable member of society” [18]. Lastly, if more educational settings were to adopt the augmented reality approach to teaching, considerations must be made to identify the potential effect this will have on current educators as not all people will have the necessary experience to develop lessons for augmentation.

2.8 Development Methodology

A development methodology is a framework that can be used to assist to structure the software development process. There are many types of development methodologies such as feature driven development (FDD) and the waterfall method. The two methodologies that will be evaluated are feature driven development and the waterfall method.

2.8.1 Feature Driven Development (FDD)

Feature driven development is an Agile development framework which as the name suggests revolves around the design and implantation of features. FDD is an iterative process and has five process steps, develop an overall model, build a features list, plan by feature, design by feature, build by feature, as seen in *figure 2*.

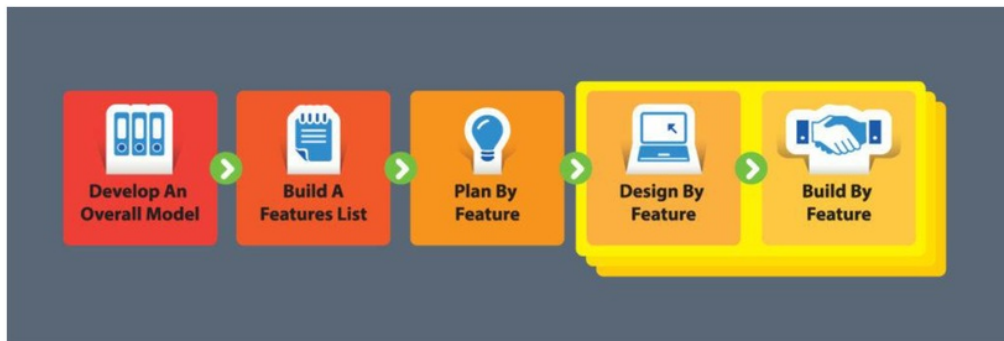


Figure 2: The Feature Driven Development Method

Image obtained from: <https://www.openxcell.com/9-things-must-know-fdd-feature-driven-development>

The process involves planning, designing features to extend the program, developing the feature and adding the feature into the software.

Advantages	Disadvantages
Rapid development due to the five-step process.	Works better with large development teams.
Rapid development of features.	Documentation is sparse.
Allows multiple teams to work concurrently.	
Less chance of ambiguity in feature scope.	

2.8.2 Waterfall Method

The waterfall method, as seen in *figure 3*, is a non-iterative approach and requires developers to complete predeceasing stages before moving on.

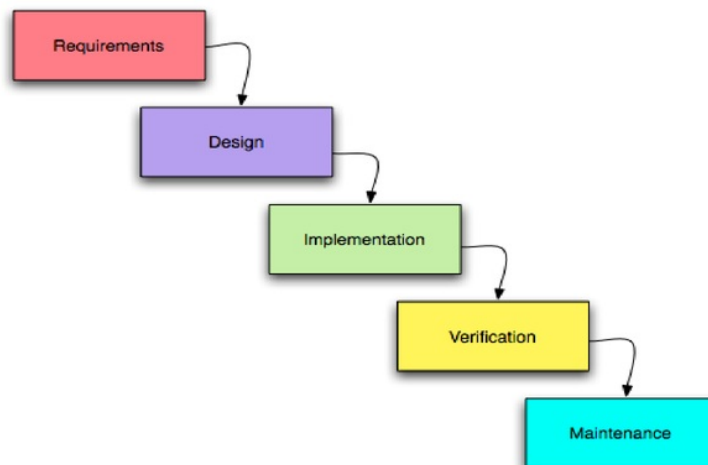


Figure 3: The Waterfall Method [19].

Advantages	Disadvantages
Step by step approach.	Doesn't account for changes mid development.
Implements strict discipline.	The testing phase is largely delayed.
	Processes can't overlap.
	Errors could potentially cause the whole process to be repeated.

2.8.3 Development Method for the Project

After analysing the advantages and disadvantages of the two proposed methodologies, the development methodology that the author will implement is an adaption of feature driven development because it allows the project essential features to be developed in small manageable workloads.

2.9 Conclusion

To conclude the research and development methods section, the author has underlined an array of possible research and development methods that could be used in conjunction with the project. Additionally, the author concluded that the philosophy that would best suit the project was positivism as this takes a quantifiable approach. Thirdly, research strategies were evaluated and appropriate techniques were chosen, these being: software development, document review and case studies as these are most commonly used in projects similar to the project being created by the author. Other elements covered include: strategies, time horizon, data collection, risks and limitations and development methods.

In the next section, the author will discuss the resources and planning needed in order to ensure time is being managed efficiently.

3. Resources and Planning

3.1 Resources Required

To be able to develop the desired project, the author will need to ensure that the correct resources are readily available. Without these resources the project could become at risk of failure. Having a list of required peripherals will help reduce the risk of running into these downfalls.

The author will need the following hardware, software and miscellaneous to be able to develop the solution:

- Computer – This will be used to build the application.
- 3D graphics framework – Unity will be used to place and render graphics.
- iPhone or iPad - an iOS device capable of running augmented reality applications for testing.
- Books – These will be used as a reference guide to support the developer create the project.
- ARKit – This will support the developer by implementing certain aspects of the AR development, such as interacting with the camera.
- Tutorials – Tutorials will give the author a more in depth understanding of AR concepts.

3.2 Effective Planning Technique

Planning is extremely important as poor management could result in the project taking longer than expected. By using a planning management tool like Microsoft Project, the chance of the project overrunning will be greatly reduced; this is because tasks can be separated into subtasks and allows the user to allocate time allowances. The writer feels that organising and prioritising tasks effectively will encourage motivation so that tasks are being completed on time. However, a problem that the user is faced with is that unrealistic goals and achievements and could become detrimental to the project. Figure (4-6) display the goals that the author has set, each goal has been given an appropriate task name and a realistic start and end date.

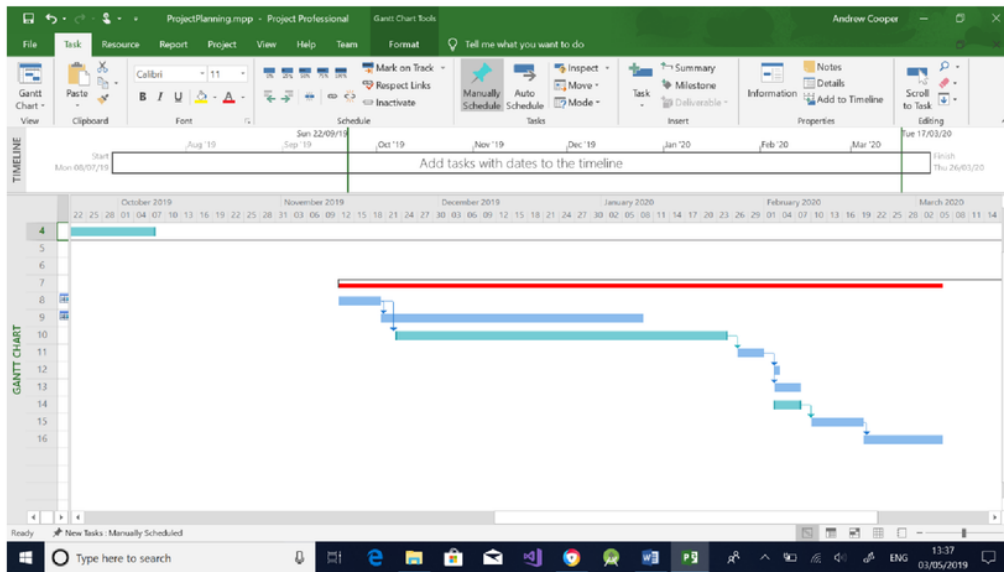


Figure 6: Calendar View of Gantt Chart Continued

3.3 Conclusion

In conclusion to the section entitled 'resources and planning' the author has created a list of resources that will be required to complete the project. Lastly, the author has created a Gantt chart using Microsoft Project as this is an effective tool to help with time management.

4. Conclusion

To summarise, the author has discussed important topics and retrieved vital information essential to the project. An overview to the background information revealed available software and methods augmented reality can be implemented in an application. Secondly, research and development methods were analysed to determine what methodology, strategy, time horizon and data collection. Lastly, the author identified resources that will be required for the project and created a Gantt chart to support time management.

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Final Submission

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

83/100

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GRADING FORM: NEW ASSESSMENT

ANDREW COOPER**83****ENGAGEMENT WITH LITERATURE**

Engagement with an extensive range of relevant and credible literature. Consistently accurate application of referencing.

20**KNOWLEDGE AND UNDERSTANDING**

Project title is very clear ;the report successfully identified a specific problem to be investigated; Well-defined aims and SMART objectives the aim is not written clearly. it can be defined and narrowed more. over all conclusion is brief but the student has other sumorative statements after most sections.

10**COGNITIVE, INTELLECTUAL SKILLS**

this report provides Clear statement of which development methods are to be used and why they are appropriate. some of the methods can arguably be not very suitable for this project.

19

PRACTICAL SKILLS



A very good application of a range of established methods, materials, tools and techniques. the students provided a list of deliverable; Clear Gantt chart showing both timing and resource use

21

TRANSFERABLE SKILLS



very well presented report. Can communicate well, confidently and consistently in a suitable medium for the audience. Work is coherent, fluent, well-structured and organised.

13