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Introduction

The Problem

Mathematics is a popular subject in which thousands of students take an A-Level in each year.[1] The number of resources available has dramatically increased for a range of topics. However, these resources are usually scattered across many pages and unordered which make using them, for an entire mathematics course, difficult. Revision websites and apps have attempted to combat that issue with the introduction of a platform in which students can revise and practice questions. A problem that is faced by many students currently when using a revision website is boredom or procrastination as you attempt to read hundreds of words on a screen and make sense of it.[2] Within KS3 resources, the implementation of games have combatted this problem, but unfortunately, this is not the case with A-Level revision.

Audience and Client

The primary audience is students who study A-Level Mathematics to utilise the functionality related to maths revision and reinforced learning. The target audience is both male and female students aged 16-19. Mathematics teachers are also a central part of the program, as they will be able to use different tools to understand how students are progressing and can improve how they help individual students.

My leading client for this project will be my mathematics teacher at the school. To better understand the specific product the client wanted me to create and the objectives that I needed to meet to produce a helpful program, I decided to have an interview with my client which is shown below.

To ensure that my project meets the specification of the client, I will be asking him to review my proposals, changes, and research throughout the project. Any feedback that requires me to change an aspect of the document will be written in red and made clear in any discussion after feedback. This will also be specified with separate headings. When I have not taken a screenshot of our email correspondence, it means that I have transcribed his response to my questions or requests for feedback. This is because my client is a maths teacher at my school and thus I will regularly be meeting with him in person. Although my client's name will be shown in the email correspondence, I will redact his email address in my screenshots.

Research Methods

To be successful in the project, I will need to carry out different levels of research at each stage of it. To begin analysing the requirements of this project and how it could be made, I will first research into existing products which have similar aims as my project. My research will also consist of discussions, interviews and surveys with my client or intended users to receive feedback and improve the product. For the coding aspect of it, there may be techniques which I will have to learn and improve on. This will need to be researched and will mainly consist of online articles, videos or documentation for a specific library. Any such research will be referenced, and my sources will be placed in a bibliography at the end of the document. A superscript number will make it clear that I have referenced a source.

Client Interview

1) Luqman: What is important in progressing in mathematics?

Teacher: *"A lot of practice in a range of questions and revising regularly."*

2) Luqman: What is your opinion on current revision resources for A level?

Teacher: *"Well, there are a variety of revision websites that students could access for free, although they may not have extensive information on each topic. It could also be a great deal of text just written on the page which is not that effective for revision, I think. "*

3) Luqman: How would you want to make revision more interesting?

Teacher: *"Interaction is incredibly important when students revise. I find students achieve a better understanding when they see intuitive examples or work through a problem with applications to something they are familiar with."*

4) Luqman: Do you think that adding games for a mathematics revision program would be useful for A-level maths students?

Teacher: "*Well they definitely need to be advanced enough for the mathematics used at A-level, but I think it's a fantastic idea to engage students in revision. I know from experience that revision can be quite tedious. I think some friendly competition also inspires students to work harder, so something like a leaderboard for games can be helpful. I would say having one game at first to see how well it catches on with students is the best option. "*

5) Luqman: I am interested in producing a mathematics revision program that is tailored to your needs, what features do you think are vital for both student revision and student progress tracking?

Teacher: "*That would be amazing! I think the primary feature I would want to see is the ability for me to check how students are doing in each maths topic. I really would like this presented clearly, for example in a table. It would also be nice if my better students could be challenged and my students who may struggle with a specific topic could practice progressively harder questions, maybe like a tier system? Of course, as we discussed earlier, if you did attempt to produce such revision resources, I would like it to be interactive.*

Summary

Based on my client interview, I found that my client will find a mathematics revision application really useful. He has made it clear that student progression is vital for him, and therefore that will be a core area of my program. In addition to this, to solve the problem of satisfying revision practice across student abilities, I think that it would be useful to have a dynamically changing difficulty level when students are answering questions – i.e. the test changes difficulty based on how well the student is doing so far. Furthermore, the use of revision resources will be combined with age-appropriate games that can improve student interaction. The games will also implement an efficient leaderboard system as my client finds that helps students to work harder. I will lay out a full list of objectives after completing my analysis.

User Feedback

To increase my understanding of what students within my school thought about current mathematics revision resources, I created a questionnaire. This will be used to support my decisions in what could be implemented into my proposed application and provide the best user experience. To begin, I needed to query the students on general ideas surrounding maths revision. This would allow me to acquire a general sense of how A Level Mathematics students approach revision. In my school, the majority of students have taken Mathematics at A Level which is why I was motivated to provide a program which could benefit them immensely.

Question 1 – "Do you revise for maths?"

Starting off with a simple question, I asked: "Do you revise for maths?". As this questionnaire was directed at maths students, I was expecting quite a high number of pupils to answer 'yes' to this question.

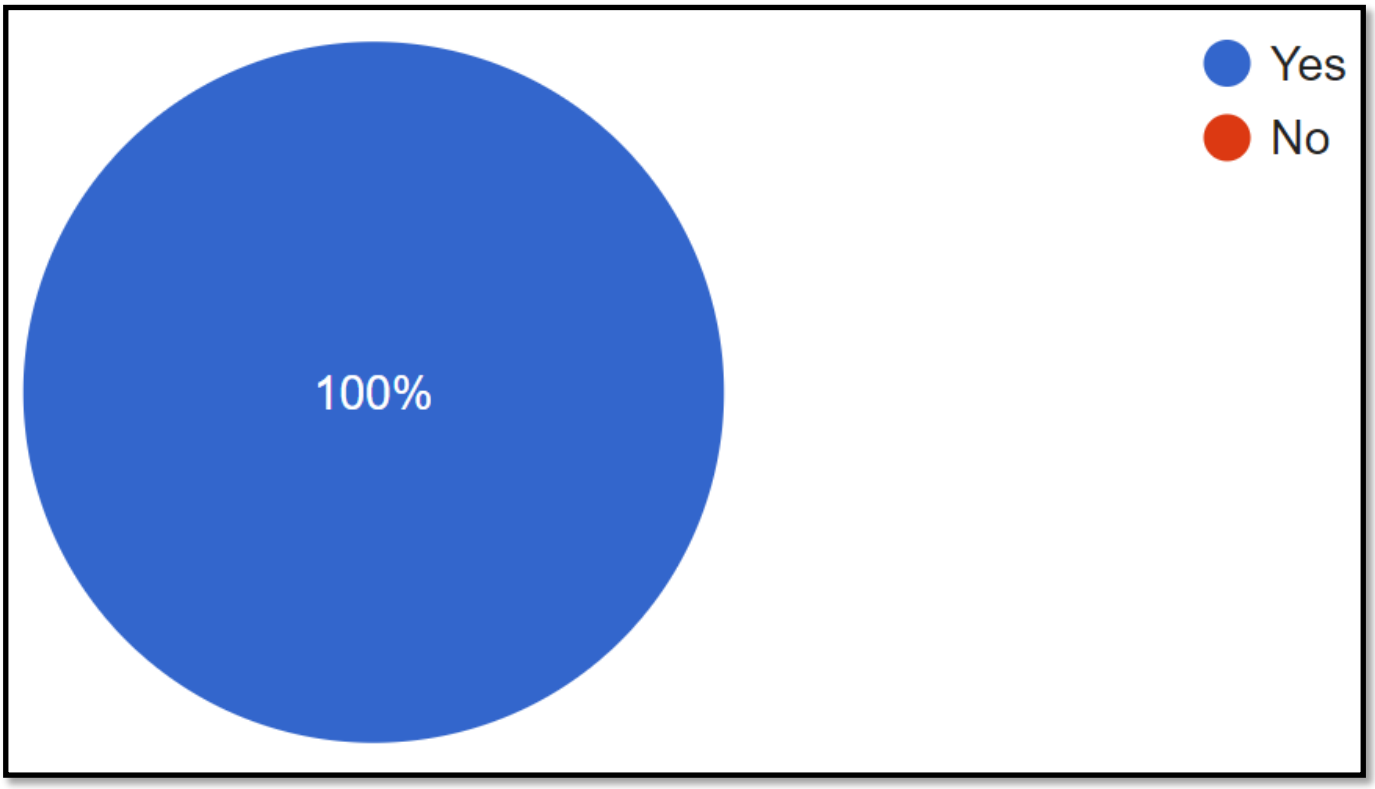

Figure 1A – Responses for "Do you revise for maths?"

My results showed 100% of students (Figure 1A) had said they revised for maths indicating the importance of revision resources to ensure that each student could be successful in their exams. This response also added to my reasoning behind developing this program as it showed that many students do revise and therefore, having a new useful resource could prove very beneficial to them when it comes to revising. It also shows how useful this product will be to my client as they can support students with their revision more closely than with external systems.

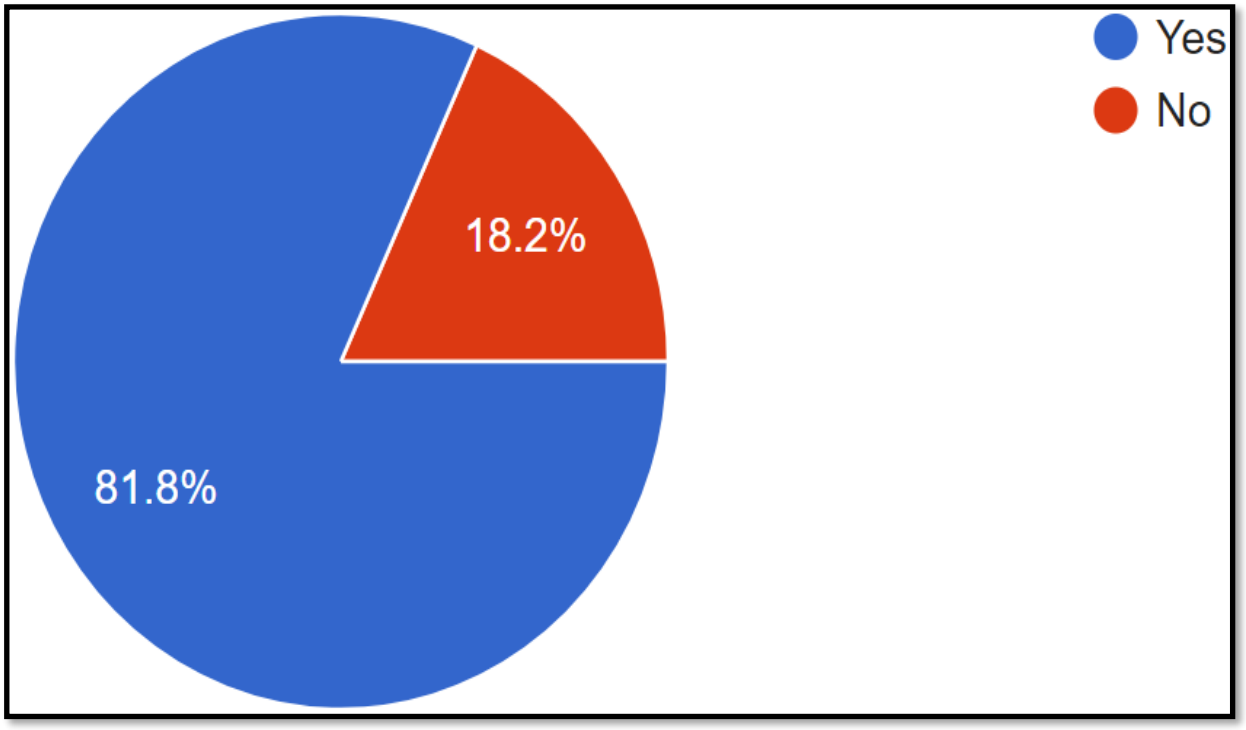

Figure 1B – Responses for "Do you use revision websites or apps for maths?"

Question 2 – "Do you use revision websites or apps for maths?"

My next question targeted how students revised with the idea of websites and apps at the centre of it. This was to see the popularity of these types of resources within my school to confirm if my program would be advantageous overall to my cohort.

The responses showed that the majority of mathematics students used revision websites or apps with 81.8% saying yes to the question asked. Some students did not find mathematics websites helpful. To further understand this response, I went and asked a few questions to both 'yes' and 'no' respondents.

When querying students on why they use revision websites or apps, I was told "they provide simple-to-understand explanations" by one student. Another one stated that "the interactive content builds a strong understanding". A third student noted that "you can find many practice questions to work with" on these websites/apps for maths revision. These responses provided me with the fundamental pillars that my own revision app should be based on so students find it useful.

However, to capture a greater audience and improve the functionality of the system, I needed to know why students did not use these revision apps or websites. This would mean that I could create a more unique and personalised program in which more pupils could benefit from, in comparison to existing systems on the market.

One student explained how “sometimes it may be difficult to search for the topic you want to learn about”. A second student told me that “If the revision content is not enjoyable enough then I will easily become distracted and procrastinate”. The consensus among the students surveyed was that one great negative is the lack of fun and exciting methods of doing their maths revision on these programs. This supported my decision to have small mathematical games implemented to provide enjoyable content that can help students and prevent their urge to procrastinate.

Question 3 – “Which topics do you find particularly difficult?”

An essential aspect of creating this program was to know which topics students needed the most help on explicitly. As I only have a limited timescale to build this program, providing resources for the full extent of the Mathematics A-Level course would impede on its functionality. This is because more time would have been spent on creating the revision sections rather than improving the ease-of-use of the program and the additional features available to the end-user and client. I asked the students which topic they found difficult, so I could target those at first and then in the future, I could add more topics depending on demand and time.

I thought of 10 topics that students may struggle with and allowed them to input their own suggestions.

These were the options:

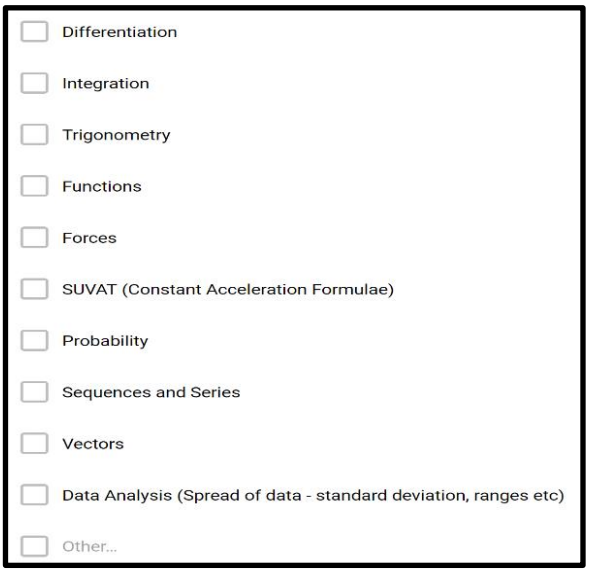

Figure 1C – Options for “Which topics do you find particularly difficult?”

The responses (with each bar in the same order as the options above with 2 'other') were:

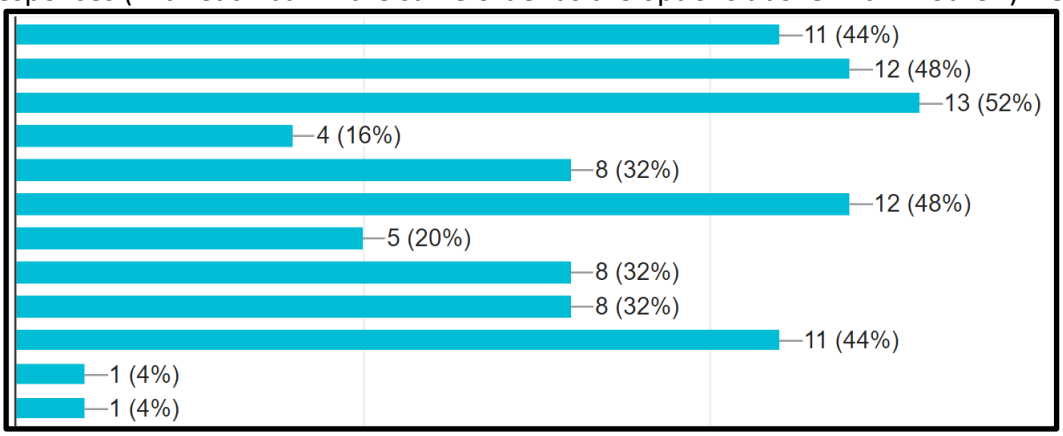

Figure 1D – Responses for "Which topics do you find particularly difficult?"

Based on my results, the 5 most popular topic areas to include (in order) were: Trigonometry, Integration, Differentiation, SUVAT and Data Analysis. At least three of these will be covered in my program for revision to improve the students' understanding and help my client in addressing where students may struggle.

Question 4 – "Do you think maths revision games will be helpful for you?"

To confirm the interests expressed by students of having games to support their revision, I surveyed pupils on their opinions on if revision games will be helpful. I included a 'yes', 'no' and 'other' option which allowed for their own inputs. This was so they could add any comments if they wished on the idea.

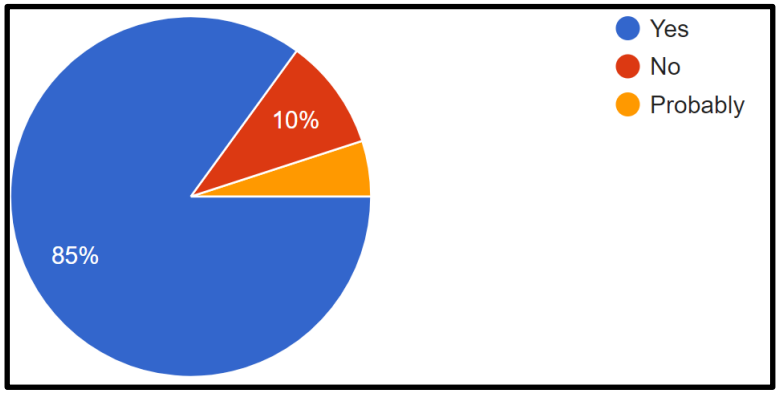

Figure 1E – Responses for "Do you think maths revision games will be helpful for you?"

My responses showed that the majority of pupils liked the idea of having maths revision games to aid their revision on the program with 85% replying 'yes' to the question. They stated that the idea of having games that can both "engage" them and "help" them would be great and reduce "boredom".

Question 5 – "How important is tracking your progress in maths to you?"

A core feature that my client wants in my program is easily allowing students to track their progress and teachers to monitor the progress of individual students, classes or their entire cohort. I asked the pupils how important this was to them to understand their opinions on knowing how they've progressed over time. This question had a linear scale answer from 1 to 5, with 1 being "not important" and 5 being "extremely important".

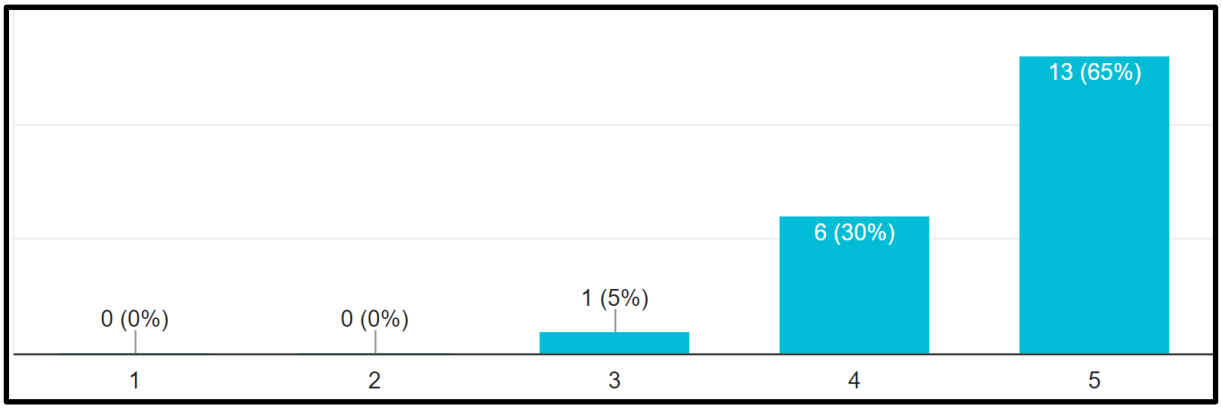

Figure 1F – Responses for "How important is tracking your progress in maths to you?"

My results showed that 95% students thought that progress tracking in maths was very important to them with one student commenting: "being able to understand your progress is vital, not only in lessons but in many other ways outside of school". This idea was useful and showed me that implementing progress tracking would be beneficial to pupils and be beneficial for teachers such as my client.

Additional Comments

My final question just asked for further comments which they may want to have in a maths revision program. I've shown the responses below.

Response 1

"I think for data revision the program could be incredibly helpful as you can use random to create random graphs and such. I think the colour is also important, if someone is spending a lot of time staring at a screen it's nice not to be constantly looking at the same colours. Levels would be helpful too as well as referral sites for extra work/help. For vectors, you could do something like a snake game where you have to use vectors to get the food..."

This student suggested having a range of colours which would make the program look better and prevent pupils from being bored by a monotone colour scheme. They also suggested adding extra links to resources to help students out more and suggested a few ideas for games they may find helpful to revise.

Response 2

"Maybe we can have a summary page of all of the formulae and equations that we need to remember, e.g. integral of tan x = ln | sec x | etc."

This suggestion would involve having a small page such as a glossary of formulae that would be useful for students to remember. To prevent me from creating a copy of the formulae booklet (which I could also easily link to for students), I will attempt to find relevant information, tips and definitions that I could include on a section which students could access

Response 3

"Lots of practice questions."

This idea will be a significant part of the program primarily as it's well known that students improve substantially in mathematics by practising a wide range of questions.

Response 4

"Diagrams"

Of course, with many topics in maths, aiding revision and understanding with diagrams is vital.

Client Feedback on Survey

I sent these responses to my client for him to provide me with feedback on how he wanted to this application to work after hearing from students. His response is shown below:

"Dear Luqman,

Thank you for sending me the results of the survey you conducted. After reviewing the comments made and looking through the charts, I have thought about the objectives I would like you to meet. It seems more important now that you should include at least one game for maths revision, as the students seem to find that helpful. I also agree with the students on which topics are difficult, as I have seen many students struggle with them in lessons. Again, progress tracking is important, and the students have said this too, so I would urge you to implement progress tracking features for both staff and for students. I agree with your idea of a glossary of math formulae as the entire formulae booklet may be a futile addition. The students have also reiterated my original comment on practice, which means that you should include a number of questions that they can work on within the application. I hope this is helpful for you to design this system and please email me if you would like me to review and provide feedback to anything regarding this application."

In summary, my client agreed with the comments the students made on the core features that the application will include. As of now, it is apparent that progress tracking, a game, a glossary page and a practice section will be vital parts of this application. I will summarise all my objectives and the requirements for me meeting them at the end of my analysis section.

Existing System Analysis

For me to produce a useful and effective revision program, I needed to analyse what some organisations provide and implement into their own existing systems. This is both to acquire positive aspects of the system that I may be able to adapt myself and to find which features I want to build upon or change to create a more refined and helpful program.

The current system that I chose to analyse was the Integral Revision Website (https://integralmaths.org/). This website provides a plethora of resources across different exam boards for mathematics, going in depth into all the topics in the course and including a substantial amount of practice questions. I chose this system as I personally have been using this for the past few months and found it quite supportive. The target audience for Integral is students studying A-Level Maths or A-Level Further Maths. One point to make is that this revision website is a premium service meaning that it requires a subscription (which our school has subscribed to) – my own program will be freely available, so more students can benefit from it. Integral also does not have any games to combat boredom during revisions sessions which is a feature my own program will include. I will provide my findings of this existing system analysis to my client to ensure he agrees to my proposals.

Existing System Visuals and Features Analysis – "Integral Maths"

The website consists of a mainly blue and white colour scheme with limited colour variation[3]. A point that a pupil made in my questionnaire was that they would like to see much more colour in my program than traditional revision websites such as Integral.

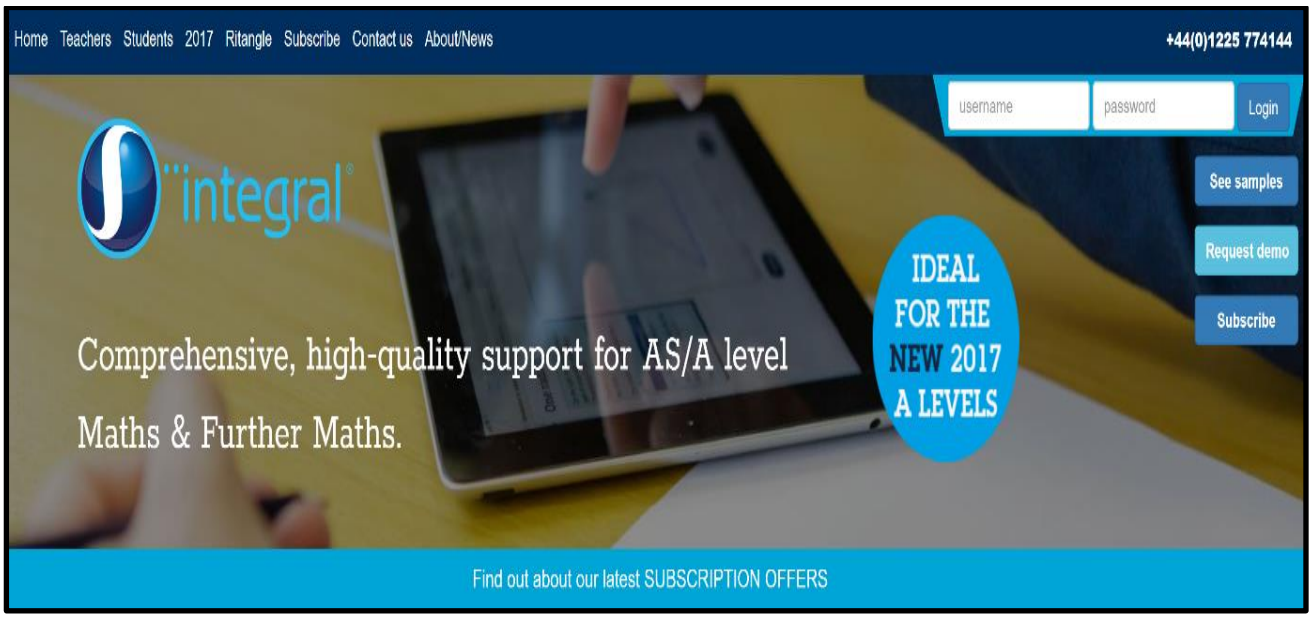

Figure 2A – Integral Maths Website Page

Although the colour may be lacking, organisation and ease-of-use is a strong point with integral. Clearly titled topics and subtopics within each module make finding what you want incredibly simple. When logged in, you have a dashboard of the modules available to you, with the option to view other modules. There is also a calendar and upcoming events section. Finally, you have the ability to customise the page as well.

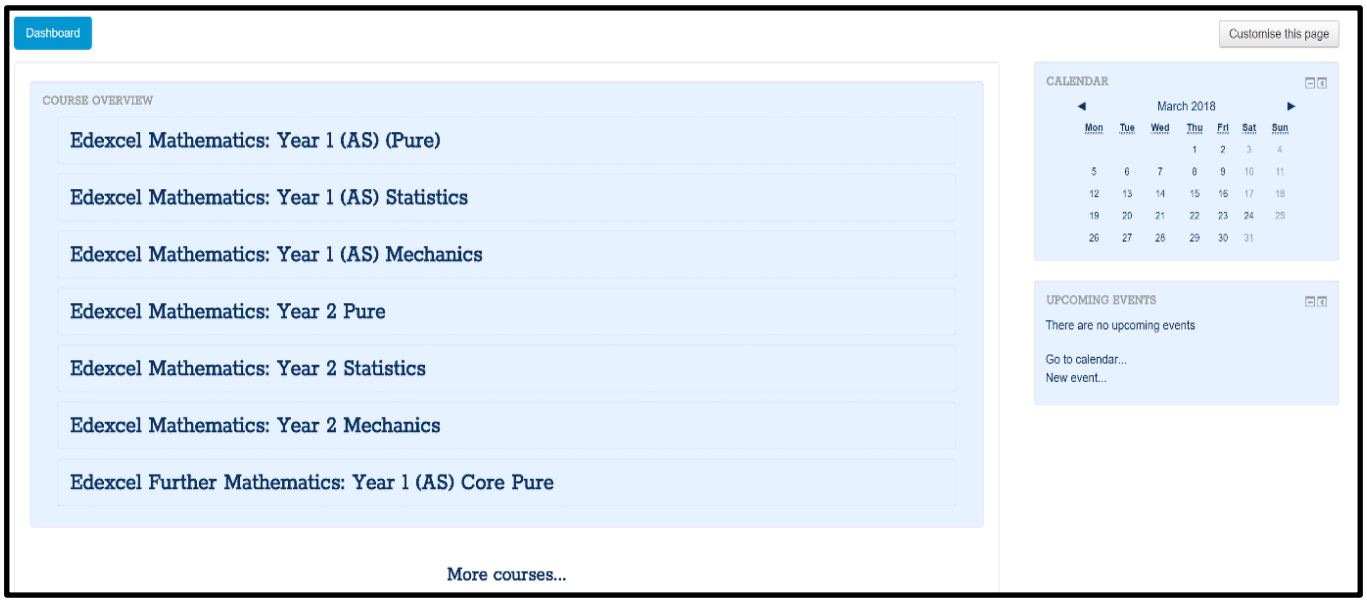

Figure 2B – Integral Maths home page after user logs in

The calendar and events section also highlights an opportunity for scheduling within my own application, as my supervisor suggested. This could take in the timetables of all users registered with the application, and when needed, it could schedule a one-to-one meeting with the teacher. This will likely be when a student is struggling or underperforming in teacher-set tasks. This could also be manually set by a teacher as it means that they do not need to ask the student when they are available for the meeting. I believe this will be a useful feature for my client.

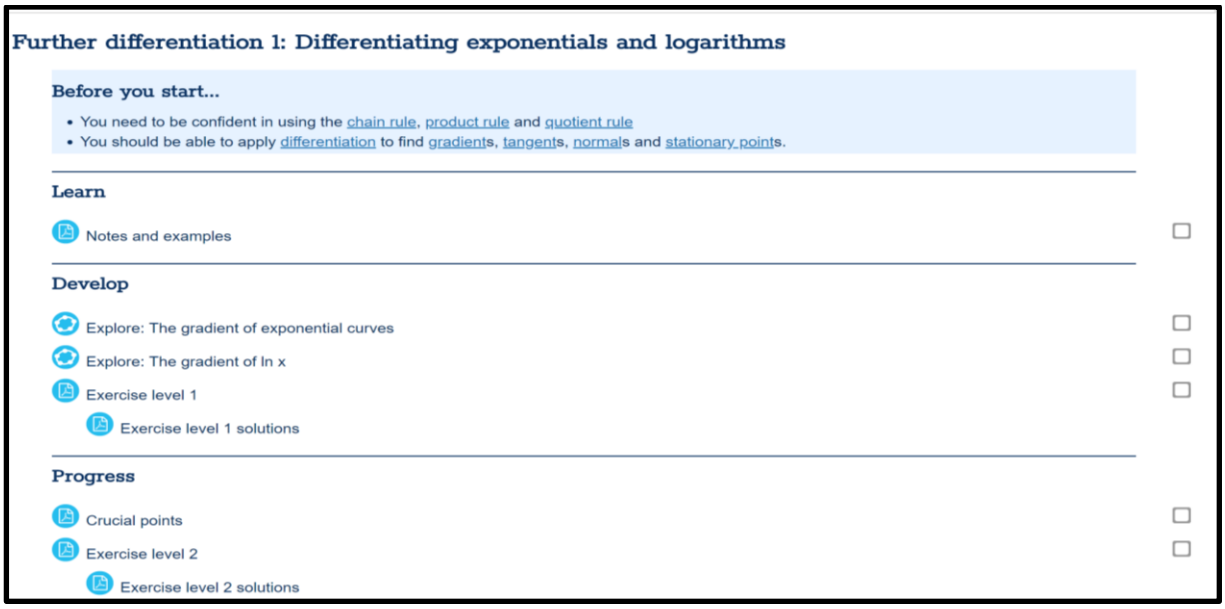

Figure 2C – Integral Maths revision resource page for differentiating exponentials and logarithms

In terms of functionality, the website is incredibly simplistic. The layout and usability are of a high standard, yet the resources that it consists of link to documents that have large amounts of text or links to external exploration pages. These 'explore' pages are built with other services such as GeoGebra which is an advanced graphing tool. There is a range of exercises to be completed with fully worked out solutions in separate documents. Although these resources are definitely useful, I feel it will be better for the user to find the majority of the features available to them within the application. I think it is crucial for me only to use links to external websites when it is necessary, such as linking to the specification website of the course.

Client Feedback on 'Existing System Visuals and Features' Analysis

"I like that you have done further research, it really shows that you are committed to helping me! In regards, to your comments, I think that the scheduler is a fantastic idea as it will make our jobs as teachers easier. With the colour scheme, I recall that colours such as green, blue and lilac are usually perceived as inviting, so I would look into using those if I were you. Maybe do further research down the line when you are designing this. I think that GeoGebra tools are quite helpful for students, so if you do plan on including links to improve student understanding on a topic, you could use GeoGebra. However, I think that if you could include your own versions of graphing tools in the application, then that would be really beneficial!"

In summary, when I am carrying out my design stage and justifying my design choices, I will need to look into the colours suggested by my client and update him on his claims. Also, I am confirming the use of the scheduler as my client approves it and I will also have an objective to attempt to create a graphing tool section within my application.

Existing System - IPSO Chart

Another important aspect of analysing the current system was to produce an IPSO diagram where I could list out the primary inputs of the system along with how those are processed, stored and eventually what the output is for that particular input. This is vital as it can provide me with background information for the primary processes that I need to be aware of and could be included in my own program.

As this is analysing an external system which I don't have complete backend access to, the extent of each section within the chart will be limited. However, this still provides an essential overview of a current implementation of a maths revision system and will help me to produce my own revision program.

Inputs	**Processing**
1) Login Information 2) Click Topic Links 3) Click Document Resource 4) Input Answers to Questions 5) Graphing Equation	1) Checks if the username and pass match database storing user details, database linked to program and returns Boolean value if details are correct or not. Triggers loading of the home dashboard if it is correct. 2) Load hyperlinked page 3) Download PDF File 4) Keyword matching and comparing 5) Using function with substituting numerical values between two limits chosen
Storage	**Output**
1) Stores usernames and passwords 2) URL of a new page 3) Stored file on their online database 4) Store answer in a variable 5) Store each value of the function after the substitution	1) Login Successful or Unsuccessful 2) Open Hyperlinked Page 3) Open downloaded PDF File 4) Statement/Image of a tick or cross informing the user if the answer is correct or incorrect 5) Output graph that has been created

From the IPSO chart above, a critical IPSO which I will be implementing in my own build will be 1) as the creation of accounts is vital in separating different users and storing specific data for each person, as well as giving teachers different permissions. I also think that 5) will be especially helpful in creating my own implementation of the graphing tools that my client suggested. This is because, with a general idea of how it can work, I am better equipped to design this feature. Finally, the use of keyword matching and comparing will be necessary when testing users on their knowledge of a topic.

Existing System - Data Volumes Dictionary

Along with the different types of data and how they may be used, it is also essential to analyse the volume of data in the current system to understand how often it will be used.

Data Object	**Volume of Data**
Test Scores	This is updated after the completion of a test or a set of practice questions
Activity Time	Records time at the beginning and end of every session (i.e. login and log out)
Answer to Question	Every time a question is answered – the answer must be stored
Ages	One per user (only used once)
Names	One full name per user (used in reminders or rankings)
Schools	Used in reminders – can be weekly or monthly

The data volumes dictionary has given me further insight into how I should design my database to cater for the varying volumes of data that will be used within it. This is because my application will likely have a growing number of users if it is released within the school. As a result of the number of users, and the volumes of data, it is imperative that I work on producing an efficient database. This means that I will need to focus on normalising my database.

Existing System - Data Dictionary

To further understand the different inputs that will be used throughout the system, I created a data dictionary for the existing Integral website. Similar to the IPSO chart, this will be incredibly helpful when creating my own program as it allows me to know and understand the different types of data that will be used in the system. Again, as this is an external system, the list may be limited.

Data Item	Data Type	Possible Examples	Comments
Name	String	Luqman	
Username	String	Luqman.Liaquat	Unique for every user
Password	String	MaThEmAtIcS123!	This is stored in an encrypted state with the use of an encryption function
Multiple Choice Options	Character	‘A’, ‘D’, ‘B’	Usually for questions
Current Date and Time	DateTime	12:00:00 01/01/2018	
URL	String	https://integralmaths.org/	
Login Successful	Boolean	TRUE or FALSE	
Numerical Answer	Float	2.435	Used for when 1 number is required
Algebraic Answer	String	$3x^2 + 7x - 3$	Used for when letters and symbols are included in an answer
Integer Answer	Integer	4	Used for when an integer is required for an answer
Test Scores	Integer	33	
Test Percentages	Float	78.6	
Box Ticked?	Boolean	TRUE or FALSE	Used for checkboxes
Login Activity	DateTime	12:00:00 01/01/2018	
Notification Access	Boolean	ON(TRUE) or OFF(FALSE)	
User Age	Integer	17	

With this analysis of possible data items and their data types, I am now more aware of how my own product can be designed with a clearer idea of how I would like to set the core variables, such as storing the outcome of a login attempt using a Boolean data type. This also reminded me about the possible constraints that I may need to place on some data items, such as when I am designing my database.

Existing System - Flow Chart

The flow chart below essentially shows how the existing system (Integral) functions with its primary purposes. Note that the ability to log out can occur at any point, but for logical reasons, I decided to have it at the end of this flowchart. Also, there are other low-level functionalities that the system could provide. However, they are not useful in conveying how the system operates as a revision program which is my main reasoning for representing it as a flow chart. The flow chart is helpful to know how (and in what order) a user may interact with the program.

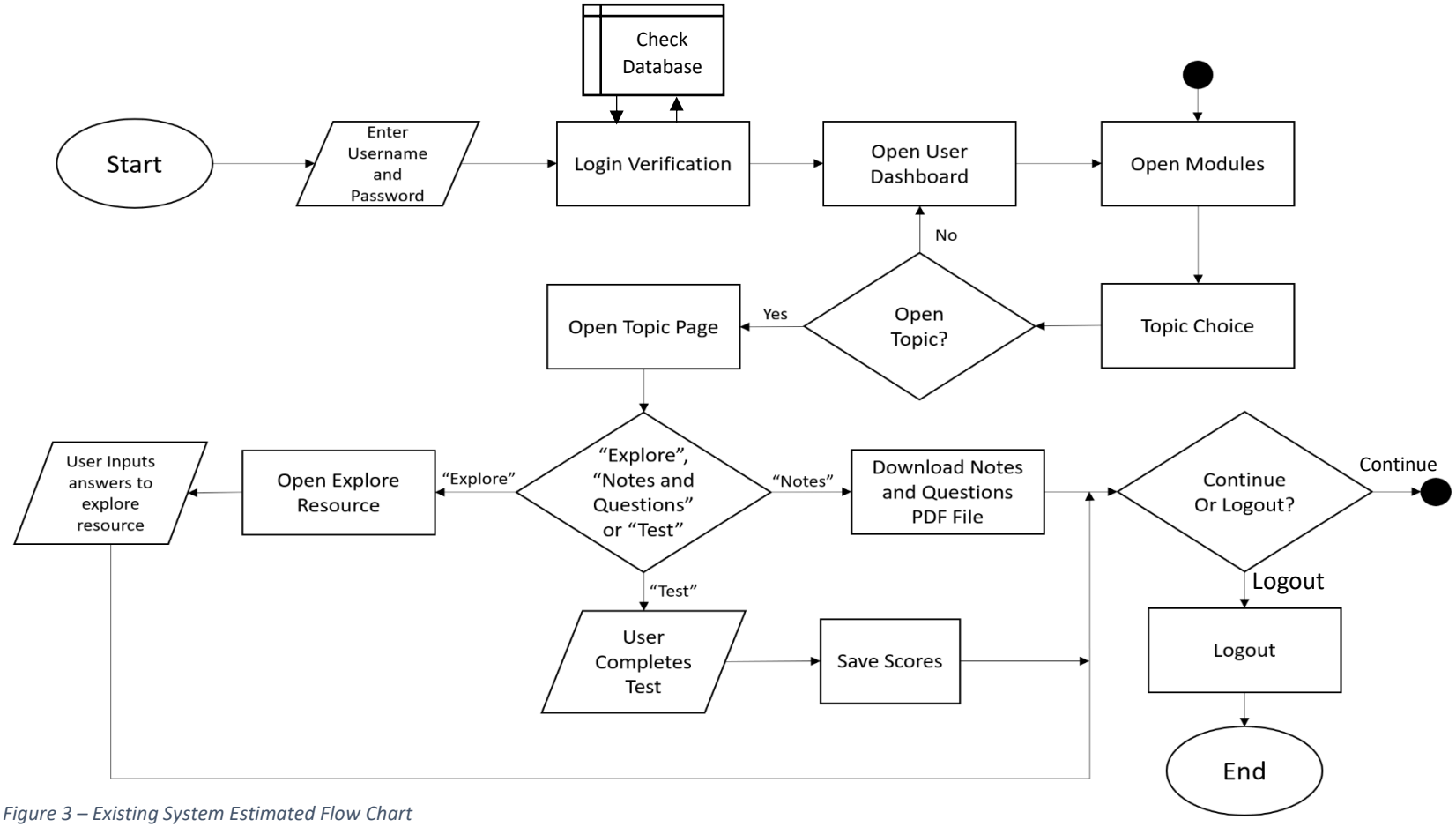

Figure 3 – Existing System Estimated Flow Chart

Existing System Analysis Summary

From the above analysis of the existing system, 'Integral Maths', I have gained a stronger understanding of what I can include in the designing section of my project. These include:

- Database normalised to third normal form to cater to the growing number of users and to uphold referential integrity when designing the tables.
- For my variables, the use of the Boolean data type will be useful in confirming the system tasks such as outcomes of logins, completion of tests or tick boxes if used.
- An understanding of how users will interact with the system (from the flowchart), such as the likely order of events: e.g. revise, take a test and check progress. This will be helpful in creating a helpful GUI.
- Knowing some core inputs, outputs and storage requirements of processes such as allowing a user to log into their account.

Client Feedback on Existing System Analysis

"Thank you again for the further details on how the project is coming along. I like how you are client-centric! I like the idea about ensuring your database could handle many users, especially if the product is fully released within the sixth form as there will be hundreds of potential users on the application. Your analysis on the existing system seems thorough, including the analysis of the types of data that is likely used in Integral. I have already commented on the visual aspects of it, so I hope you will design that well. I will leave the technical side of the variables and these data types to you, but in general, it sounds like an application which I will enjoy using! It would be great if you could create an overall summary of the application's objectives so I know that it is in line with my interests. Thanks!"

Game Survey

From my analysis and previous surveys, it is evident that both my client and the students want a game implemented into the revision section of this program. As a result, I have created a survey for students to complete, and the results will be discussed with my client to confirm the final choice for the game. For this application, there will be at least one game for one revision topic as my client suggested in our first interview. Using this survey, I can order the choices for games, and if possible, I will continue to add in additional games and features beyond the requirements of my client, if time allows.

The introduction to the survey, which all users see is shown below:

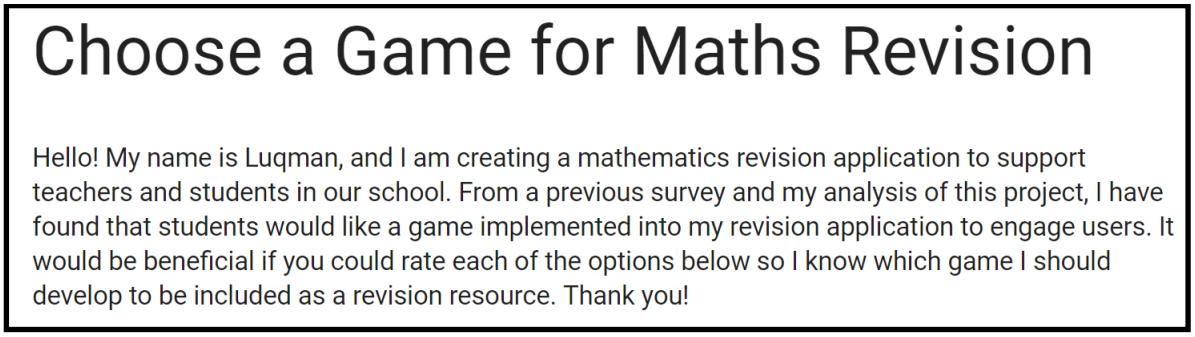

Figure 4a – Introductory description to survey for which games to use within my application

The 5 options in the survey were as follows:

Option 1 – Maze Game

Option 2 – Ping Pong

Option 3 – Pac-Man

Option 4 – Space Invaders

Option 5 – Snake

The description along with the results for each option will be shown and explained in the subsequent pages. There were **20** Maths Students that responded to this survey. This survey will be instrumental in informing me of how the Game aspect revision program will work.

Option 1 – Maze Game

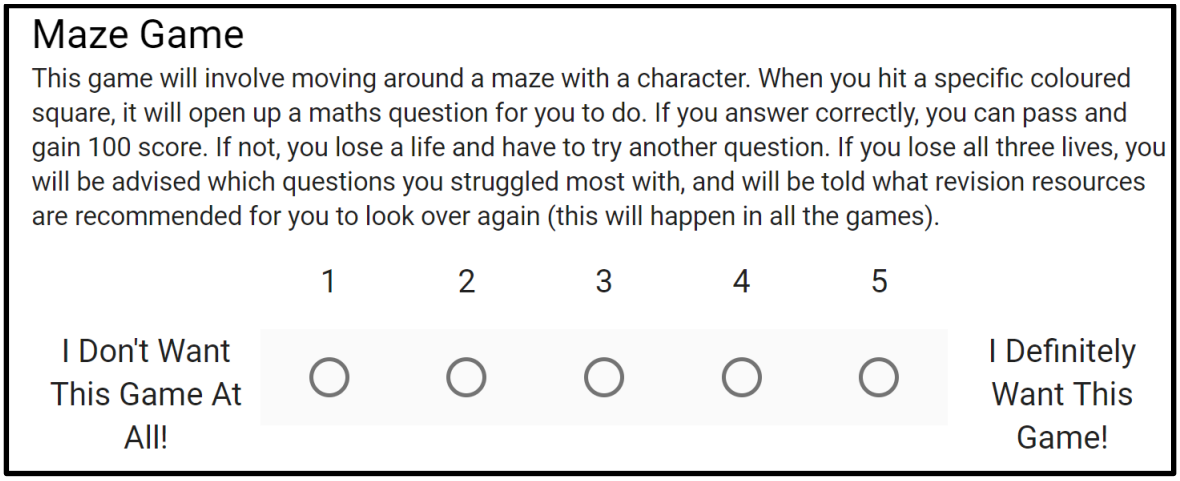

Figure 4b – Proposed Maze Game Explanation

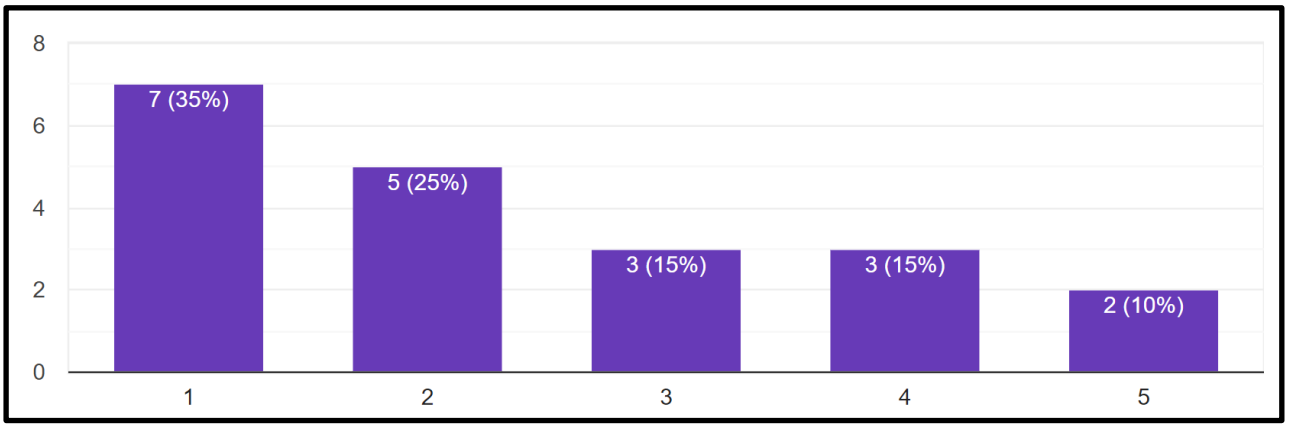

Figure 4c – Responses for Maze Game Option

From Figure 4C, it is evident that there is a weighted distribution of responses with a stronger focus on not wanting this game to be used. There were 8 students on a neutral score or higher for this option, but the majority have shown they disliked this idea. Some comments from responders are shown below.

Comment 1 – Maze Game

"I don't think it will be that fun of a game compared to having a maze game by itself. It may get annoying if you think you're getting somewhere, and then just stop to answer a maths question. To be honest, in the other options, you could include some sort of endless mode, which this maze game cannot do well."

Comment 2 – Maze Game

"In the context of a maths revision application, the maze game may not gel well with the revision question concept, so I don't think this is the best option."

Option 2 – Ping Pong

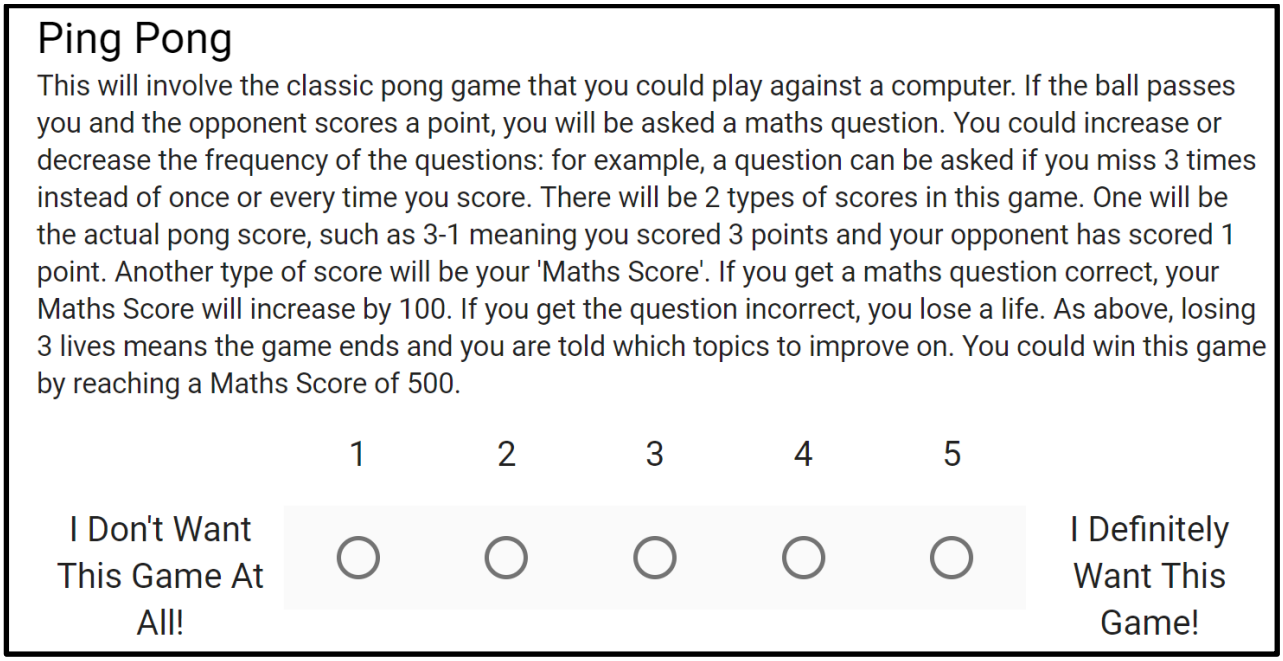

Figure 4d – Proposed Ping Pong Game Explanation

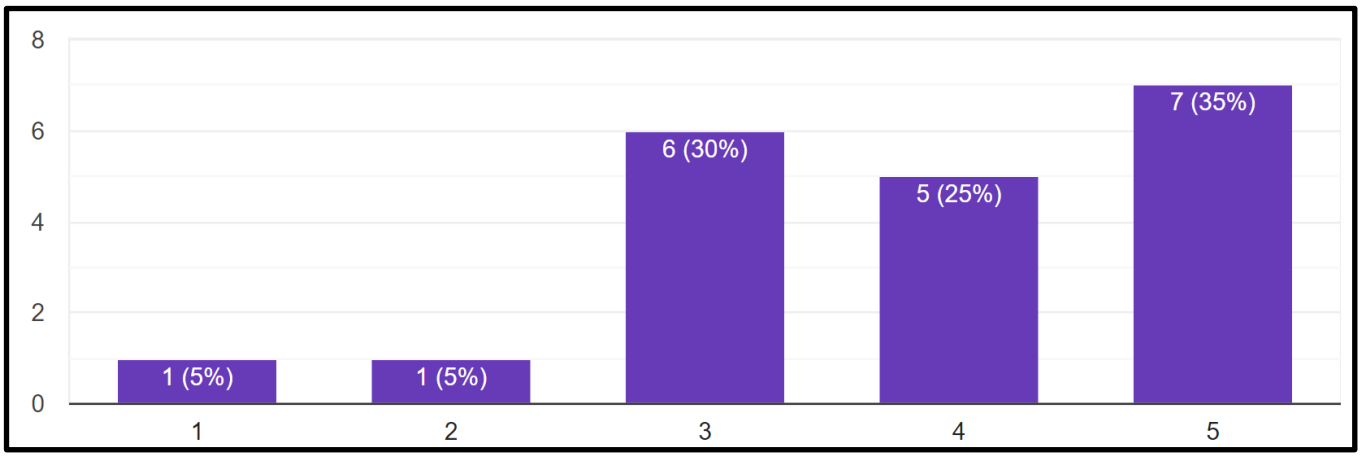

Figure 4e – Responses for Ping Pong Game Option

Figure 4e shows that many students like the idea of having a Pong game with only 2 students below the neutral mark. This game is very popular but seems to fall short of the Space Invaders results from Figure 4i. This is likely going to be my second choice in my list, but I will need to confirm this with my client. A comment on this game was:

Comment 1 – Ping Pong Game

"I think Pong gives a decent balance between playing the game and solving maths problems. You'll be able to fit in many questions into a single session. I also like how it can have the competitive side to it as well, so it is a well-rounded game for the maths revision application purpose."

Option 3 – Pac-Man

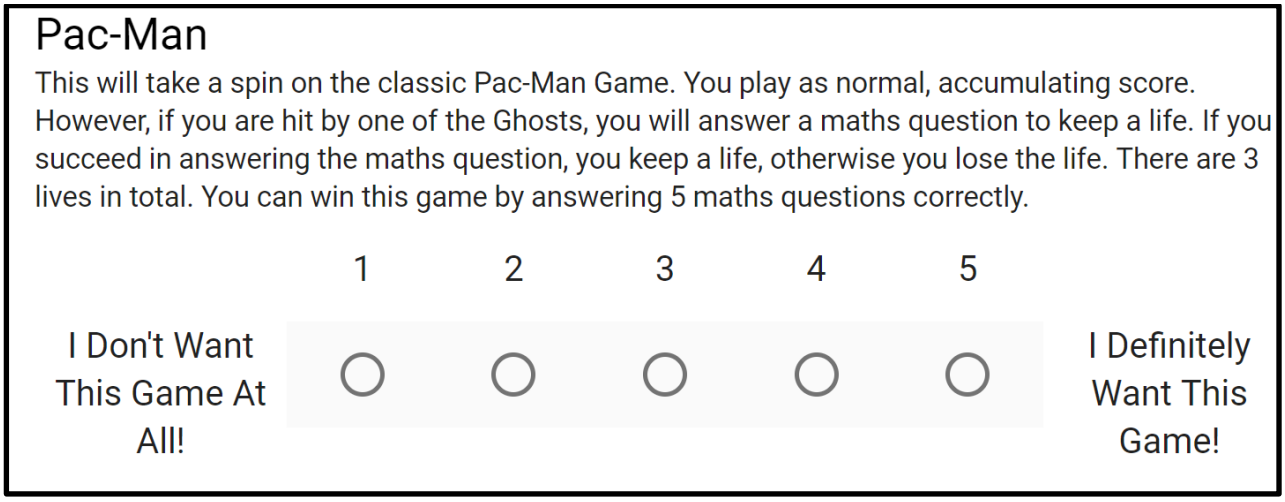

Figure 4f – Proposed Pac-Man Game Explanation

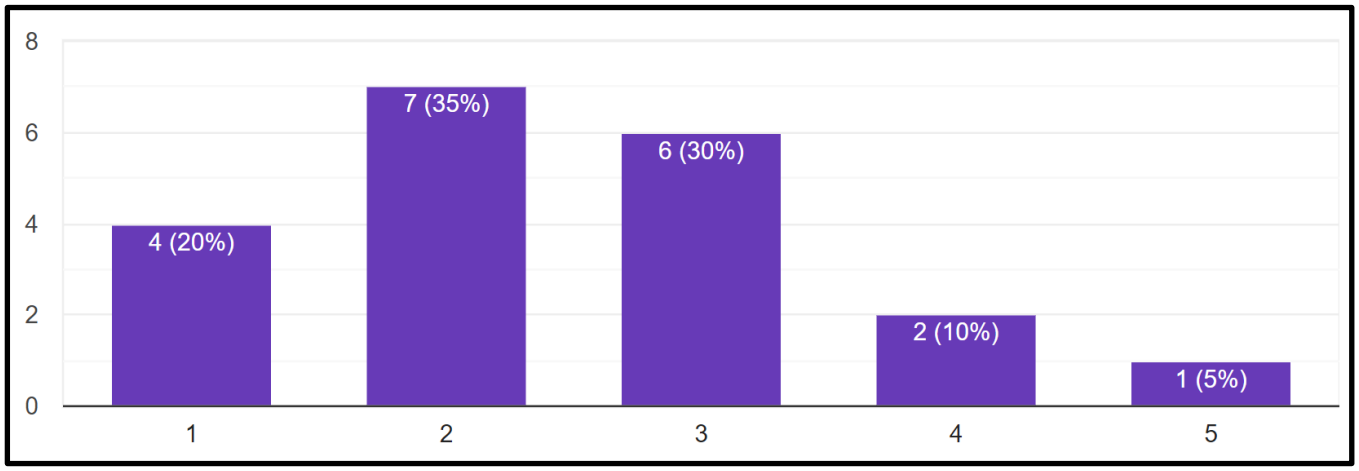

Figure 4g – Responses for Pac-Man Game Option

The results shown in figure 4g suggest that the maths students do not want to play Pac-Man as much as the other options that were given. There is a majority towards the lower score of 2 while only 1 person chose it as a must-have game within the revision application. Here are some comments that the students made on this game:

Comment 1 – Pac-Man Game

"Although Pac-Man is such a popular game, I think many people have played it quite often and, for me, it isn't as engaging as it once used to be."

Comment 2 – Pac-Man Game

"I think Pac-Man is a great game, but I don't think the additional maths revision questions combined with it will be useful for me personally. I prefer some of the other options that you have created to this game."

Comment 3 – Pac-Man Game

"The sound may be quite distracting for when we want to do the maths question, even though you could probably mute it, it doesn't seem like a good match with maths revision."

Option 4 – Space Invaders

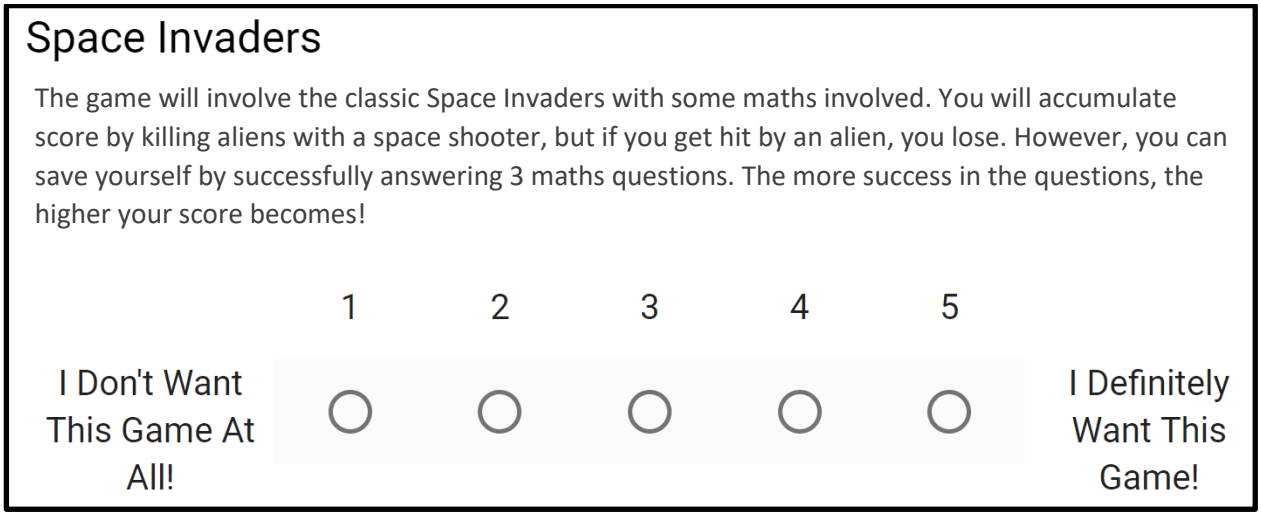

Figure 4h – Proposed Space Invaders Game Explanation

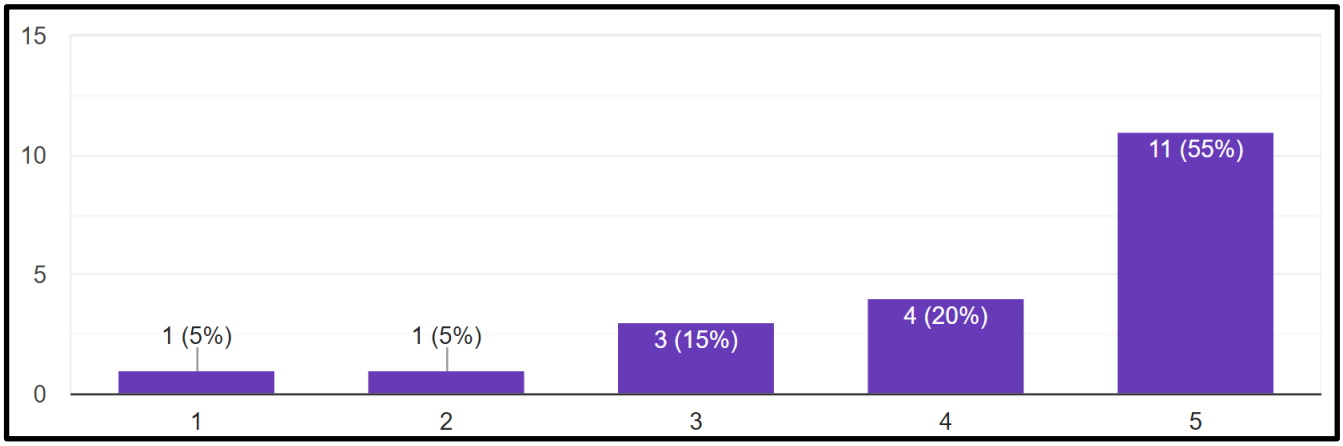

Figure 4i – Responses for Space Invaders Option

Figure 4i indicates that the Space Invaders game idea is quite liked among the maths student with 18 students scoring it with a 3/5 or above and 11/20 giving it a maximum rating. This game idea is quite promising, so I decided to ask some students what their comments on this game were.

Comment 1 – Space Invaders

"Space Invaders is always pretty fun, and because of its fast-paced nature, it will really get you going in thinking about your next move. I think it would mentally prepare you for the maths questions if that even makes sense!"

Comment 2 – Space Invaders

"I think space invaders sounds interesting as you can have quite a lot of versatility in the types of questions that can be used in one game. There is pretty much an unlimited number of colours that can be chosen, so the number of topics for the game is expandable as well."

Option 5 – Snake

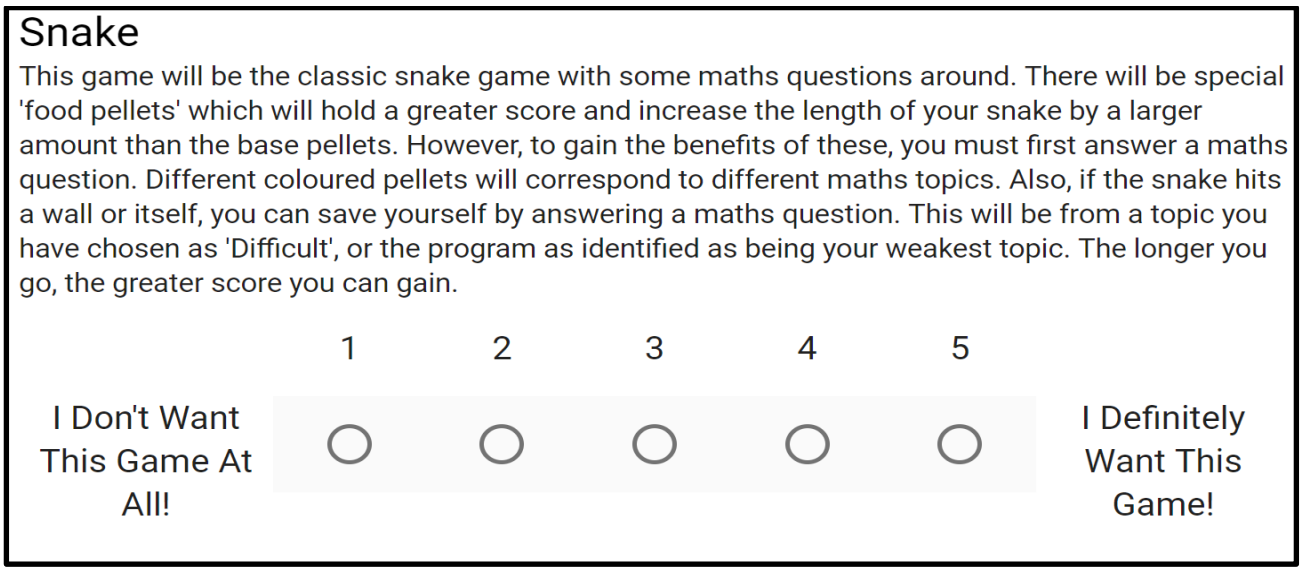

Figure 4j – Proposed Snake Game Explanation

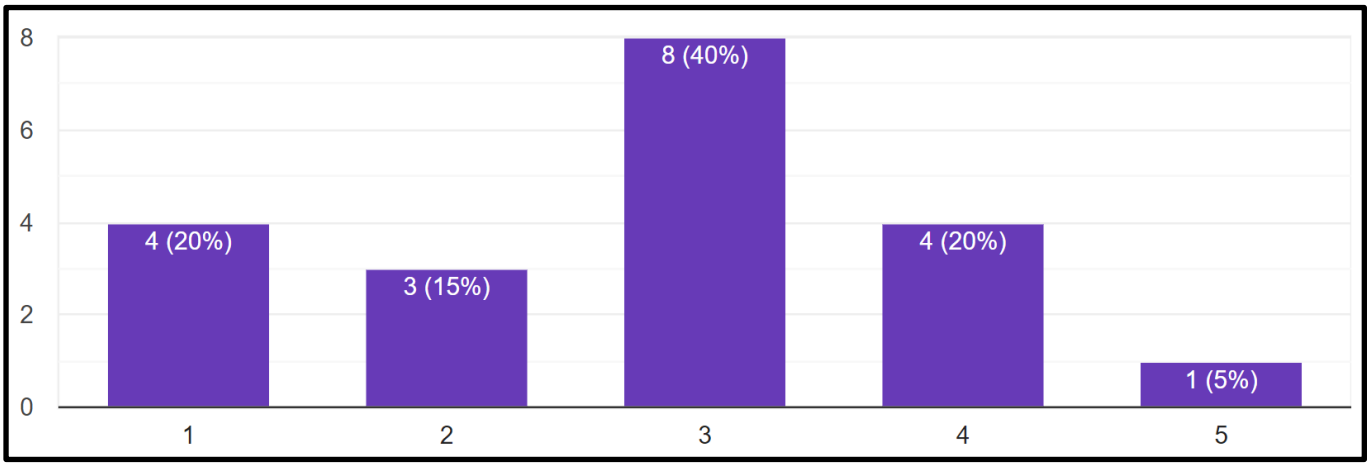

Figure 4k – Responses for Snake Game Option

From figure 4k, the responses for the Snake Game idea have been quite mixed. It doesn't seem like a top candidate for the game, but it is not the worst choice either, giving it a middle ground for my list. I have asked a student on their perception of the idea, which is included below.

Comment 1 – Snake Game

"There is a lot of customisation you can do to this game which I think will be a great idea. I like having different colour pellets and bonus scores for correct maths questions. It seems like it will be a fun game, trying to get the highest score in our class and revising at the same time."

Game Survey Summary

From the student feedback, I have created a list in order of priority below. As there will be at least one game used, the first choice on the list will definitely be included in the application, while subsequent choices have possibilities of being included (depending on client feedback).

Priority Level	Game
1	Space Invaders
2	Pong
3	Snake
4	Pac-Man
5	Maze Game

I emailed the survey results and my conclusion to my client for approval to ensure the product maintains its accuracy in what the client wants. The reply is shown below:

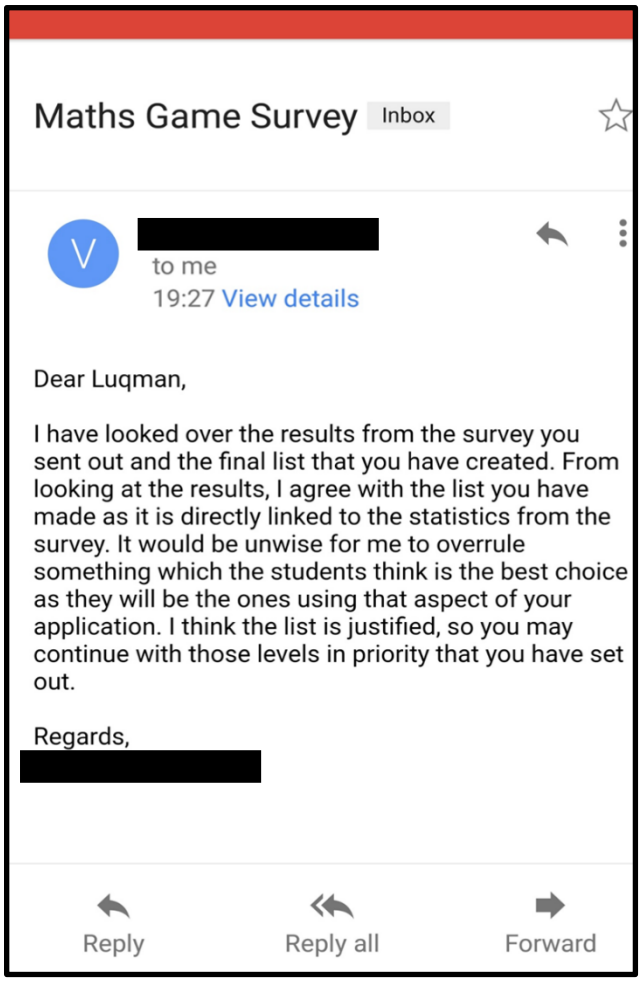

Figure 5 – Client Feedback on Game Survey

From this feedback, I can continue to use this list for the priority in which game I am going to develop for the revision resources.

Possible Solutions to Create Application

To be prepared to begin my design of solution of the application required by my client, I need to ensure I have looked at several possible solutions. These are solutions to the problem of how I will create the application. I have created a table below which describe ideas of possible solutions.

Possible Solution 1	**Possible Solution 2**	**Possible Solution 3**	***Chosen Solution***
My first solution involves using off-the-shelf software and attempting to adapt and improve it to produce what I need. However, this may be problematic, limited and I may not have access to the source code of the software which is not helpful	My second solution is using a high-level programming language. The language I currently use is Python, and it will be able to handle the different functionalities I would like to program along with the freedom of having full control of my code. This will also be paired with Kivy.	My third solution is to use a "brick building" environment such as 'Scratch' as that will be much simpler than the other two options. However, this loses an incredible amount of complexity, freedom and I won't be able to create exactly what I want due to the limitations	My chosen solution is to use Python to program as it allows me to use programming to its full extent in developing this system and can give me the freedom and control to make exactly what my client needs.

I have chosen to use the Python programming language as it will provide me with a plethora of tools to build all the core areas of my application. With the ability to import additional libraries of code, my technical solution can be more efficient and tailored strongly to my client's needs. Python is especially useful for my application as it is almost a hybrid programming language, supporting both a procedure-oriented and object-oriented paradigm. With this flexibility and with the portability of the language, I think that using this programming language for my product will be the most effective method in producing an efficient application for my client. In particular, I will be utilising IDLE as it is a simple integrated development environment (IDE) and will allow me to quickly work on my programming and test the code with clear outputs. IDLE will also direct me to an error that I have made at runtime because Python is an interpreted language so it will translate line-by-line when it is run[4]. This means I can rectify problems quickly and focus on meeting the objectives that I will set with my client.

Analysis Summary

My objective is to produce a revision program for my client which adapts the positive aspects of other applications and combine it with the critical functionality of progress tracking for both a student and teacher. This will also simplify the process for a teacher to identify the weaknesses that a student may have and give them a helpful overview of a class or even year group. My program will integrate gaming functionality with thoughtful and useful revision sessions to maximise a student's understanding of the topic as they attempt to revise. Visual cues and physical actions are found to be more easily remembered then merely reading text[5].

The concept of progress tracking is vital for both students and teachers as confirmed from my survey and interview. My program will actively analyse students' achievement in given tests and questions and decide how the difficulty should change until the student has either reached the highest difficulty or the program recommends them retaking a revision lesson. These dynamic changes in difficulty are how a student can learn and challenge themselves as they can reinforce their learning.

Teachers will be able to have access to data on how students are doing in the available topics. The teacher will receive information for each of their students in a class and quickly be able to check which students have used the program, which questions they did well at, what topics they require improvement on and time spent on each section with average scores.

An important point to make is a limitation that my application will have. As there is limited time and I am working on this project alone, the revision sections will not be extensive. This means that I cannot cover every aspect of the Mathematics A Level Specification for revision resources, tests and games. However, as time progresses, additional topics can be included. As a result of my survey that I conducted with students, I know which few topics I will focus on for the revision side of my application. This will maximise how beneficial it is to both my client and the intended end-users.

To simplify how I will achieve my client's intended application, I will split the program into several objectives with performance criteria. This will also make it easier for my client to check if the proposed objectives are in line with their own interests for how this application should function. I have included this extensive analysis of the objectives on the next page.

Specific Objectives

No.	Objective	Performance Criteria
1	An easy-to-use GUI	Colour coding with clear buttons for the user to navigate around the system.
2	An account system where each user has their own account with a username and password.	**A)** Usernames must be unique. **B)** When logging in, the password should be hidden by asterisks. **C)** The password should be stored in the database as a hashed value (no plaintext to improve security)
3	Practice tests section for any combination of topics with ranges of difficulty that change based upon user achievement within the test or in prior tests.	**A)** Take in student test data and run different functions to work out how they're making progress **B)** Questions should be marked by the program using keyword recognition/ Number recognition.
4	A support section for revision which includes at least one game to prevent boredom and increase student's memory of the topic.	**A)** The first game developed must be 'S.I.' and if time is available then continue down the priority game list defined beforehand. **B)** An efficient leaderboard sorting system to rank players.
5	A database linked to the program to store all student details and information, so the teacher can easily see what each student has done, their strengths and weaknesses and how long they've spent using it.	**A)** Implementation of the database should be completed within Python for efficiency **B)** The database must contain several related tables which cover all aspects of data storage of the application
6	Progress tracking for students Class overviews for the teacher (my client).	Have a tracking section with the ability to output tables on the specific data received for that particular user. Allow the teacher to check specific students' progress.
7	Have 3 major maths topics from Differentiation, Integration, Trigonometry, Vectors, Data analysis (statistics) – this can involve the study of probability distributions and measures of central tendency	Each topic should have its own set of revision materials to help the student revise.
8	Create an automatic meeting scheduler for one-to-one meetings for the teacher and student	**A)** Require input of each user's timetable for their account to ensure both parties are available for the meeting **+ B)** Send an e-mail to teacher and student

Critical Path Analysis

Following on from my objectives, to streamline my process for producing my application I will create a critical path which I will follow. This is the general order for the completion of the objectives to ensure that, at the earliest stage possible, there is a fully working application with the core ideas of a maths revision application. The numbers I will refer to are from the objectives table on the previous page.

First: *Objective 5*

Creating a relational database is an essential feature used in the data analysis, progress tracking, account creating and scheduling aspects of my application. Without this, I will not be able to continue meeting the objectives.

Second: *Objective 2*

The account system will allow me to differentiate between users and design the remaining features with specific user accounts in mind. It will also allow me to begin creating my GUI as you need an account to access the rest of the application.

Third: *Objective 1*

This will form the basis of the application and will mean my designing and my programming will have to be influenced by how the application will look. This is an integral part of the application and will be worked on throughout the entirety of the project.

Fourth: *Objective 7*

With the creation of revision resources, I can continue on building the testing, progress tracking, and games section of my application.

Fifth: *Objective 3*

This is a vital part of the application to support the teacher and student and one that my client is particularly fond of.

Sixth: Objective 4 and 6

These two objectives will be closely linked as they will require a data collection element along with the progress tracking for each user. They will heavily rely on the relational database that I will create.

Seventh: Objective 8

This objective will require the previous objectives to be completed and therefore will be completed last.

Timescales

To plan my project well, I need to set timescales and deadlines which to meet. This will also allow me to better evaluate the success of the project. The actual time spent on each task will be broken down in the Evaluation section once this project is completed. I will also comment on how I think I did in terms of timing in that section.

Task	**Allocated Time**
Analysis (This section) and Research (Throughout)	10 Hours
Design	12 Hours
Technical Solution (Coding)	25 Hours
Technical Solution (Alpha-Testing and Documentation)	6 Hours
Beta-Testing (External Users)	1 Week (for users to use and feedback on the program)
Evaluation	2 Hours

This project will take approximately 55 hours to complete, and with 6-7 hours spent a week on this project. The timescales above are for my own reference to complete the project within around two months as advised by my client. Therefore, I will be keeping track of these myself as my client only expects the final product within two months after making the agreed objectives list.

Overall Analysis Client Feedback

To confirm that the objectives that I had laid out were what my client wanted, I sent my analysis section to him, with the updates on the objectives, performance criteria and the critical path. His response is shown below.

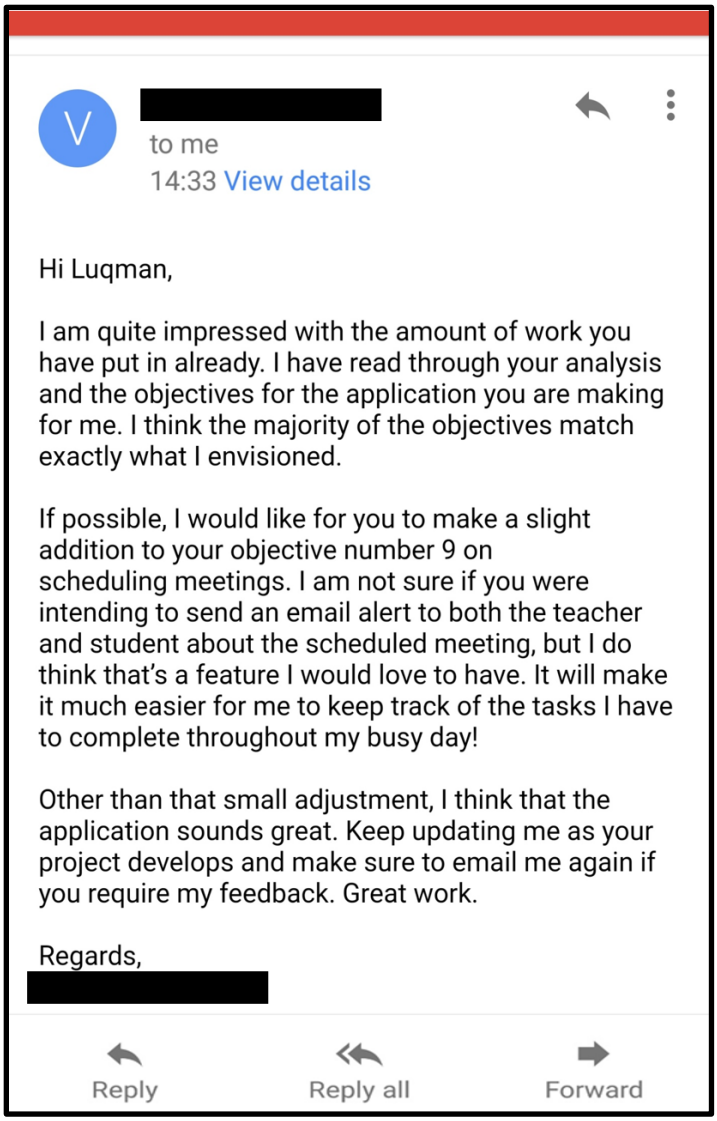

Figure 6 – Client email providing me with feedback on my Analysis

Overall, my client approves the objectives that I have created, with the only change to make being the addition of an email alert for ***objective 8***. Please note that objective 9 has become objective 8 as I have combined two similar objectives into one objective after I had sent my document for review to my client. This change was in objective 3 where the previously separate objective of '*actively changing difficulty*' has been included into objective 3: the objectives have not changed, just their positions in the table have moved by 1.

I have updated my original objectives table on the previous page and have added the change in red to show it was written after my feedback from my client. Now that I have analysed the existing system and have clearly laid out the objectives along with the performance criteria, I will begin designing my application.