**Okuk Reflections**

For me, the project was of great interest because I believe there is potential to improve the quality of teaching in particular subject areas.

I have often found when studying complex process and structures in biomedicine, the models and diagrams we are given to aid our understanding are either too complex or too simplified. As such, there is significant ambiguity regarding how processes are […] carried out and this poor understanding is often not recognised until crucial moments such as examinations.

I was incredibly enthusiastic about this project because, despite my little Minecraft experience, I have seen many examples of the incredible modelling experience Minecraft provides.

My intrigue in this project was to find out if Minecraft could be an effective educational tool, particularly for a student such as myself who sees the benefit in creative forms of learning.

# The Project Overview

We were given very little information regarding the protein as I believe the purpose was to explore the topic ourselves, in order to find our own areas of interest. I was comfortable with the research aspect as this was not dissimilar to work I have done during the semester and it did not require a significant stretch in the existing research skills I have obtained whilst at university.

However, it must be noted that CAMK2 is a highly complex protein and there is a significant amount of information surrounding it, therefore it was initially difficult to focus in on a particular area.

I found that 12 hours was a reasonably lengthy amount of time when researching CAMK2. I personally elected to work in 2-hour bursts, as beyond that point looking through papers became tiresome. In the end, I likely spent 6-8 hours on the research stage. Spending less time on this stage was beneficial in providing me with more time to work on the designing and making of my model.

Personally, I found it difficult to go straight into modelling my E/F hand domains after researching- most likely due to my lack of experience and confidence with the software. Therefore the flexibility in timing was certainly helpful encouraging me to persist with the work as I did not feel bad spending more or less of my allotted time on a section.

With regards to feedback and recording our progress, we were offered the use of Trello which allowed us to summarise our recent activities and outline our targets. Early on in the project, I was very keen to use the programme because I appreciated the highly organised layout of the page and I felt that it would help keep me up to date. However, as the project progressed I found that my designing and reflecting process is very random and very difficult to compartmentalise using a web planner. As such, I freely recorded my thoughts and ideas in a small notebook.

# The Realm experience

[…] I was interested in determining the usability for someone with similarly minimal experience. My initial impressions were that it was generally very user-friendly. Within my first hour of trialling the programme, I was familiar with the relevant keyboard controls, the location of the tools I would use for building and generally how to navigate the realm.

One thing I did note was that there is the initial struggle to refrain from destroying items by clicking incorrectly, which may prove frustrating for some learners. However, this mishap improves drastically within a short time-frame and there are certain tools you can hold (such as the sword) which prevent the user from being destructive.

[…] I particularly enjoyed the first-person point of view as I felt this was an excellent way to experience a model. It created a more personally interactive experience, which I believe creates more understanding. For example, whilst studying my anatomy course, I have found that my information intake and understanding is greatly increased when I am actually holding the structures I am studying. The realm provides this because I can physically move around a model and appreciate it from a variety of angles until I can make sense of it.

In regards to working in the realm, I generally found it quite daunting. The open plan nature of the realm we were given to work on, whilst sufficiently spaced, did make me feel slightly self-conscious.

In the early stages of the project, I knew I was not yet in a place to produce the impressively complex models that I could see my colleagues building. Moreover, I had previously determined that the best way to increase proficiency with Minecraft was to experiment with a range of structures, yet I could not bring myself to do so in front of my other teammates.

Arguably, due to the nature of the project, my situation is unique and a much larger class of students working in a realm will have a greater number of inexperienced users, thus reducing the chance of feeling self-conscious. However, some students may still experience that feeling which may harm their learning. I then began working in my own realm as I felt much more at ease trialling very simple methods.

[…] I was incredibly impressed with the design potential. The variety of textures available, the functionality of the pistons and levers and the signalling properties of Redstone, all provided an excellent foundation for brainstorming my initial design ideas for modelling the E/F Hand domains. Initially, I wondered how limiting exclusively modelling with cube-shaped building blocks would be, however, I found it reasonably easy to build much larger, alternative shapes by simply layering the blocks.

On the other hand, the vast array of design potential was hindered by my inexperience. I felt that my design ideas were limited by what I could see in my toolkit and without scrolling through every available tool, I found it difficult to brainstorm. Essentially, the foundation on which to build my ideas upon was present but I lacked the knowledge to represent these ideas in Minecraft.

It seems that time is needed to prior to designing to simply know how a feature could be used. Whilst this is suitable for an exploratory internship project, it may be more challenging if set as a task for students as some will require additional time to learn the basics.

An easy way to circumvent this will be to predesign models and allow pupils to learn via exploration. However, this will remove the aforementioned benefit of interactive learning.

Despite this challenge, I generally found that as I developed my model, I better understood how to use each feature and my general confidence using the software increased.

Therefore this small criticism does not discredit its educational potential as it simply means that sufficient time must be allocated for familiarising yourself with the software.

# **My Design**

The first stage of the project led me to focus on the calmodulin protein, specifically the E/F Hand domains. I was aware that members of the team were well-experienced in using Minecraft, hence I decided to focus primarily on creating an effective educational model rather than a unique, complex Minecraft model.

Initially, I created a very basic, structural representation of the two E/F hand domains which did not take long at all. I then increased the scale of the design and tried to create a more structurally represented model. Going back to the aforementioned point on the difficulties of sharing a realm, this is one of the instances in which I personally found experimental design to be difficult as I could clearly see the much larger, complex structures other team members worked on. That being said it did inspire the increasing progression of my design ideas until I ended up with an Idea I was happy to develop.

I elected to create a dynamic functional model of the initial entry of calcium into the E/F hand domains of calmodulin. As this followed the rule of attraction, I was led to the use of zombies and villagers as these are two components in the game that are closely linked together. I ultimately chose this model because it fulfilled my aim of creating an educational model to represent processes that may be hard to visualise otherwise.

My design progressed from a simple structural model with no moving parts to one that used Redstone, repeaters, pistons etc. I also managed to encase the model in a structure that resembled the shape of the calmodulin domains.

On completion of the model, I felt satisfied that it would be an effective visual representation of the calcium-binding the E/F hand domains. However, I had greatly simplified the content I had initially researched in order to develop an idea I could model. As such the concept I modelled would not be too difficult to visualise with a much simpler static model.

**However, I feel that a Minecraft model has more learning opportunities than a static model. Despite the relative simplicity of the aspect I was modelling, I did find that my understanding of any related topic was reaffirmed as I attempted to build my model. I think that having to creatively represent numerous aspects of a design forces you to better understand what you are designing.**

In terms of conveying my design to others, I think the explanation of my concept would best be represented by the use of lecterns. Lecterns allow space for a suitably descriptive explanation of a concept and can be used to guide a user through your model in a way that is most beneficial for their learning.

In my model, I was slightly concerned that the numerous moving parts in my model may be distracting making it harder to understand, therefore lecterns would be incredibly useful here. I sought some informal feedback from students with non-biomedical backgrounds and they indicated that whilst they understood the basic concept, the number of moving features in the model should be kept to a minimum as it makes the model harder to follow. They also agreed with the use of lecterns to support the model. Additionally, lecterns can be used to break down the design of a model to allow a user to recreate and expand upon it. In my model, for example, I would use the lecterns to explain the purpose of particular tools such as repeaters and the terracotta blocks. The aim would be to provide the user with an in-game tutorial to follow.

I am currently working to produce a dynamic, functional model of the conformational changes that occur in calmodulin activation. I am hoping to use elements of coding in the design and ultimately determine if a student with minimal experience can produce a more complex model.

# Teaching Potential

Based on my initial experience with the software, **I am currently of the mind that Minecraft would best serve students in both tutorial and practical work**.

I personally felt that the interactive nature of modelling and learning simultaneously will allow students to tackle difficult topics in a practical way. Initial ideas that come to mind are recreating molecular analytical techniques, which are often very difficult to visualise, or modelling complex renal processes.

**However, I do also feel that this will not be sufficiently effective unless students are given time to develop their model.** As previously discussed, students with limited experience will need time to improve their confidence with the software and familiarise themselves with the available resources. Given this compromise, a project such as this would exceed the allocated time for a tutorial or a lab and if this were to span multiple sessions, a student would then need to be credited for this effort.

A potential method would be to use the lecture content to teach the modelling skills. The student could thoroughly learn the components of a pre-made model in the context of the topic they are learning. For example, a tutor can take a premade model of DNA replication and break it down to its individual components. They can then match this alongside the process of DNA replication to show how the model represents each stage. The result should be that the student can appreciate processes in both a stepwise manner and in terms of a larger system. Hopefully, the student can then begin to manipulate aspects of the model or recreate parts of it. Learning in this manner also allows the tutor to clearly relay the expected level of detail required, as the model will represent exactly what they have chosen to include.

This steady pace of working may best suit a longer assessed task such as an in-course assessment or an honours project. However, an in-course assessment often brings additional pressure due to various other activities and assignments a student may have. Therefore, this style of learning may be better suited for a less time-constrained assignment like an honours project. The honours project gives the student the opportunity to remain focussed on one task so that they can build up the necessary experience before diverting to more complicated design ideas.

**To conclude, I am very in favour of the use of Minecraft in university education, particularly for computational biology. Currently, it is very difficult to visualise complex concepts and the models we use in class lack the visual appeal that makes them useful learning tools.**

**Generally, modelling opportunities are minimal in my degree, most likely because the software is too expensive or too difficult to use. Traditional learning styles are not ideal for learning the increasingly complex structures and processes we are faced with. We need a more active learning style and I feel that Minecraft may be the refreshing learning experience we need to bring in this new learning style.**