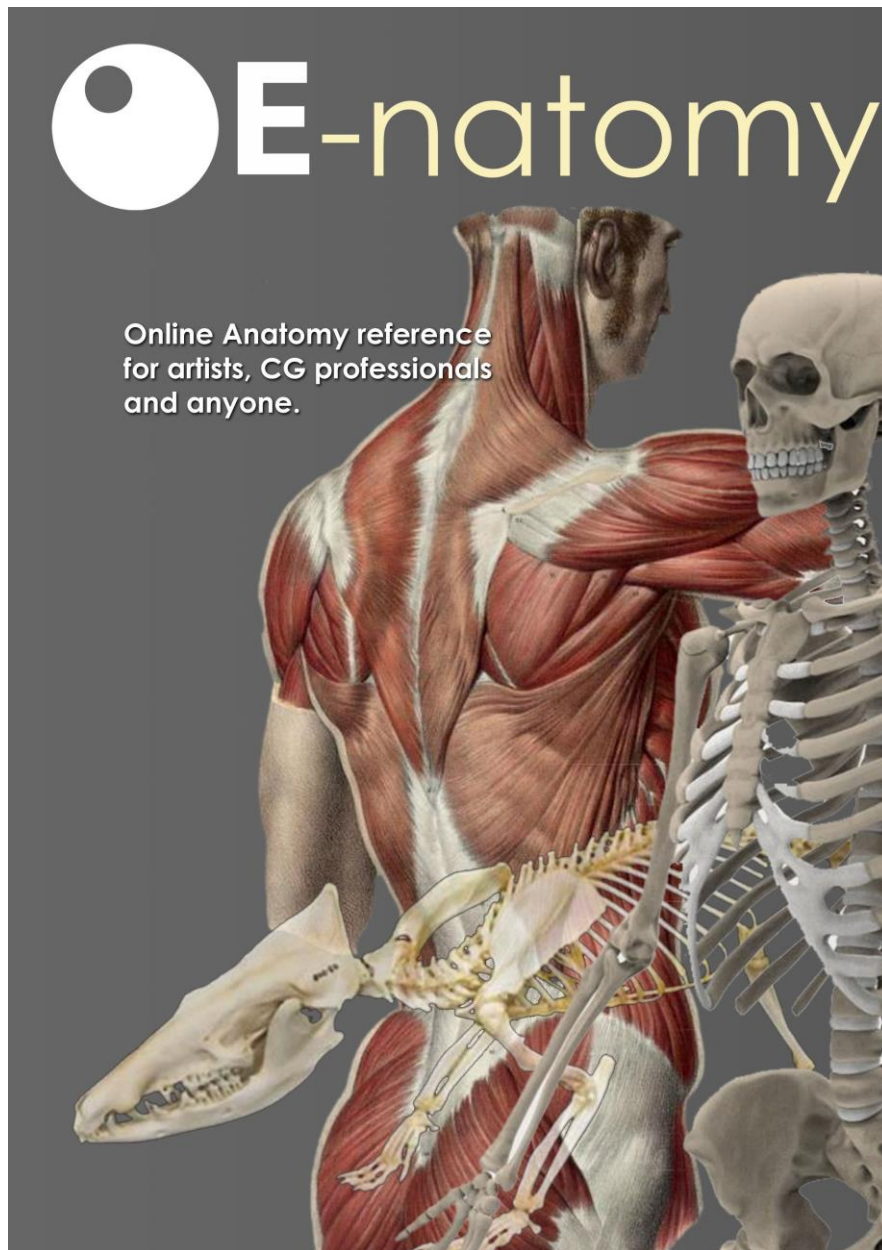


Technology Enhanced Learning Environment

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1. Intro

This report documents the concept, design and development of an idea for a learning environment which incorporates some kind of technology. This could be similar in concept to the idea and the experiments with the 'Teaching Machine' developed by B F Skinner and Sidney L Pressey in the 1960's.

Initially attention was given to how technology can help create and improve learning for the student and if this model can be applied to any topic. To do this it seemed choosing a topic would be a good place to start. From a shortlist of topics, (**Appendix I**), 'Anatomy for illustrators and modellers' was chosen as the topic for this learning environment. A few instances had occurred in a short space of time where the developer had been approached by someone who needed a way of looking at 3D anatomy models on their phone / tablet / laptop to use as reference while they were drawing or sculpting. This seemed like enough motivation to look into the current solutions and see if there are any and if they fulfil the requirements of the learner. People had asked for reference material for human anatomy as well as animal anatomy, so an environment was envisaged that would cater for someone who wanted to learn more about all types of anatomy not just human.

The technology would simply replace the need of wooden mannequins and live drawing models or maybe it is inconvenient to go to life drawing classes.

2. Background / Related Research

From experience and listening to the thoughts of artists in general, good reference material is sought after to improve the quality of work produced, whether for a hobby or a professional situation. It seems that using a screen with a 3D model on it that can be positioned correctly is enough to vastly improve the students figure drawing or quality of artistic output in general. To begin with, online and downloadable applications were researched to view what already exists. A list of applications was produced and their functionality analysed:

1. Ken Hub [Ref 3]

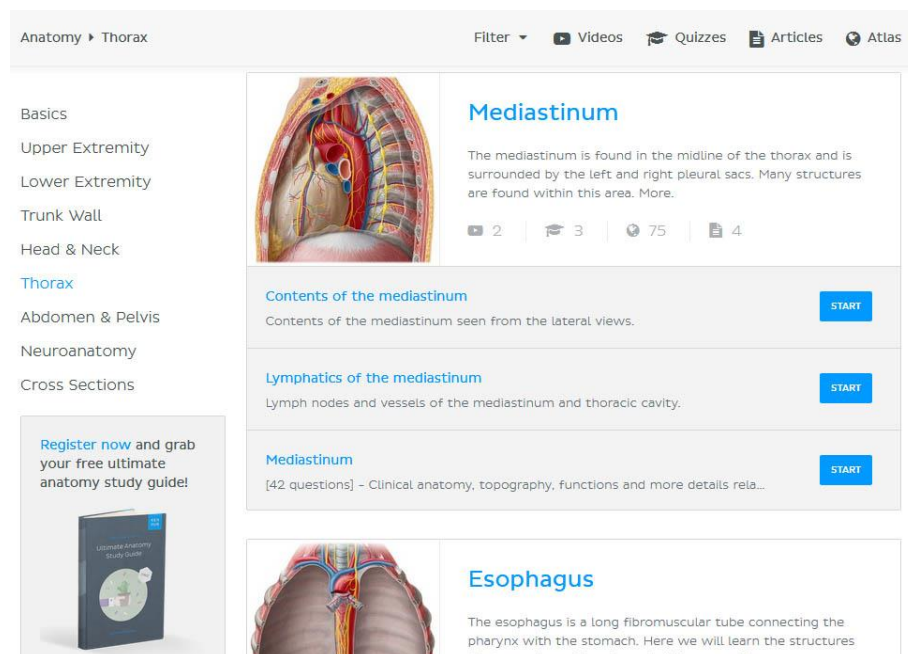


Fig 1. Ken Hub screen example

This is an online tutorial aide. It has video tutorials and a lot of text based tutorials and quizzes that use 2D illustrations to convey the knowledge. It's a bit like a big e - book with some accompaning videos. It doesn't have any 3D at all and shows only human anatomy.

2. Anatomy Learning [Ref 4]

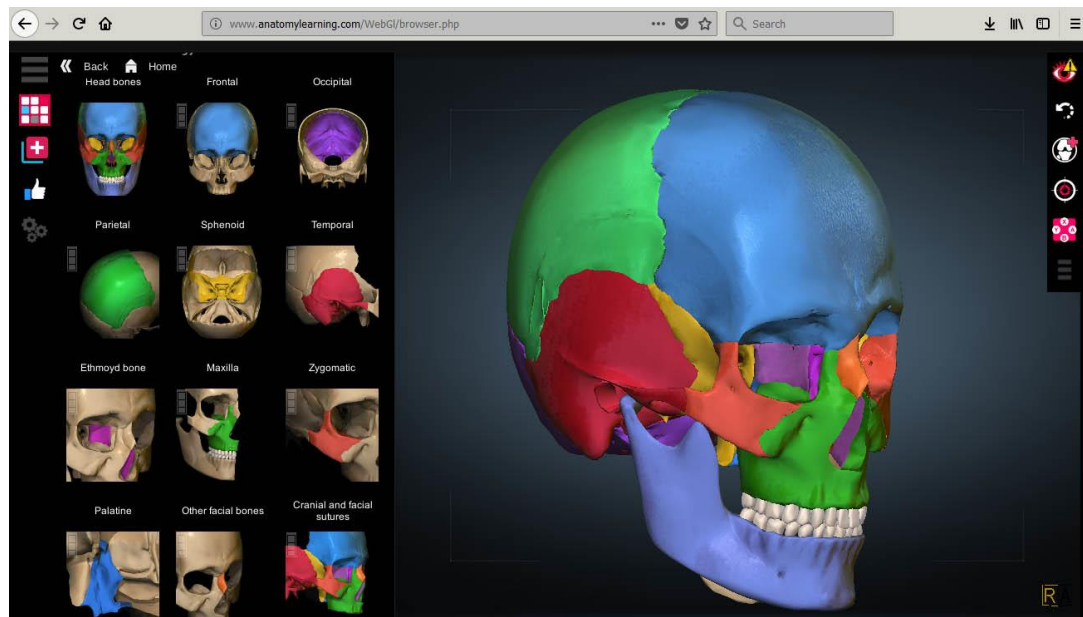


Fig 2. Anatomy Learning screen example

This application is more like what is being proposed in this assignment. It has a lot of 3D and seems very informative. Displays in a browser with no need for download on a laptop and developed using Unity. Overall this application looks like it is aimed more at medical students, but does show the learner anatomy in a lot of depth if that is what is wanted. There are no other species shown, only human anatomy and the application comes across as overly complicated with an unfriendly interface (Fig 2). It is also cumbersome and slow loading.

3. 'I Muscle' - 3D4Medical



Fig 3. I Muscle screen example on mobile

This application is a very nice piece of work (Fig 3) that shows anatomically correct 3D models of human anatomy. It is aimed at 'Health and Fitness' and is for phone or laptop. It contains the feature of stripping away muscles so the user can see what's underneath, but a lot of the application is totally built to demonstrate fitness and how exercise affects which muscles. The application is built around the needs of instructors and physiotherapists so it doesn't naturally cater for the needs of artists and modellers.

4. '3D Anatomy for the Artist' – Catfish Animation Studios.

This application is the most suitable existing solution found in this research session. It covers all the basic needs and requirements for an artist or modeller, displaying the imagery in 3D and allowing the student to load up body sections and poses to work from. Only human anatomy and no other species.

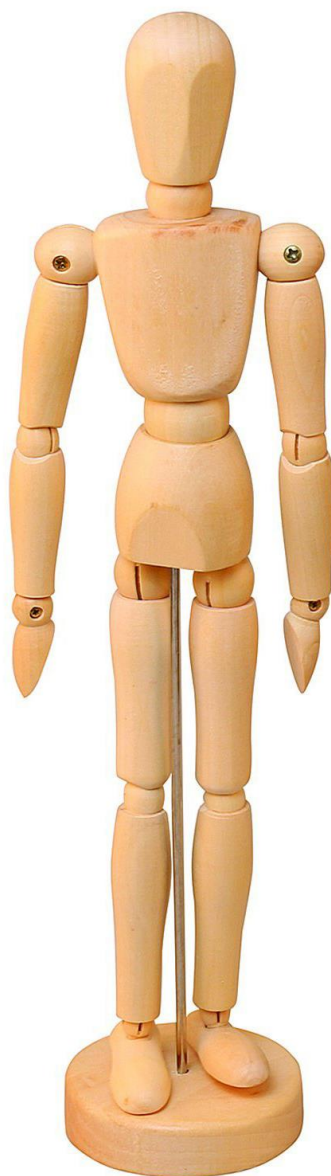


Fig 5. Wooden Mannequin

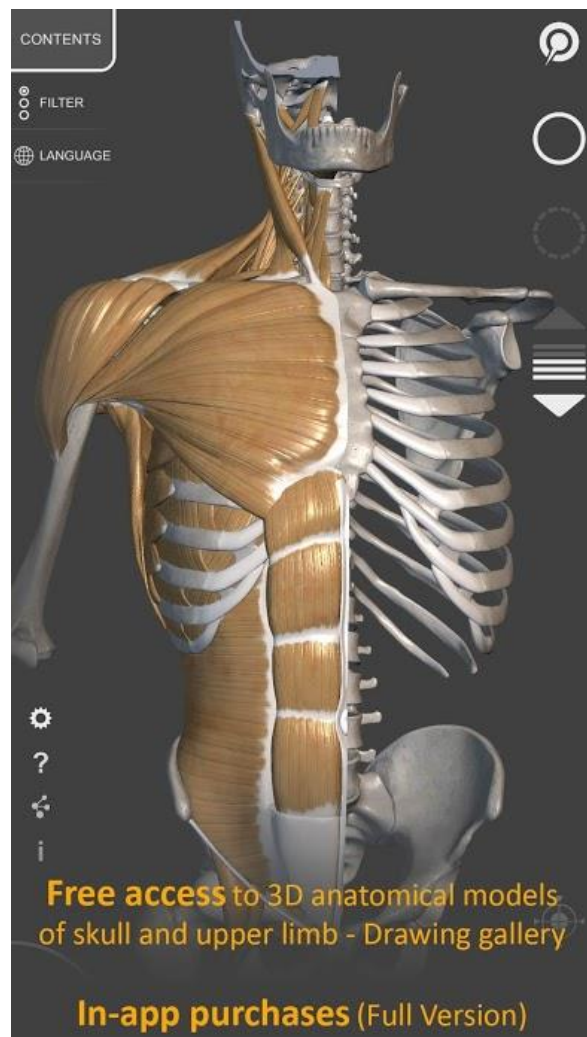


Fig 4. 3D Anatomy for the Artist

A lot of the traditional 'Teaching Anatomy for Artists' books that are out there tend to look at the old masters for inspiration. These masters would use live human models, and in cases such as Leonardo De Vinci, would use cadavers to study the inner workings to learn more and improve their work and understanding. Artist instructional books push the idea of using proper reference like a human life model or use photography to show how to produce a copy of the figure through illustration or modelling.

Using 3D models that can be posed would be the equivalent and probably better and more convenient than having to have to find a live model or go to life drawing classes. Life drawing classes would be a good solution and this technology can easily replace the live model and the tutor who wanders around checking on your progress and gives you feedback. There is also the technique of using a wooden mannequin which the proposed environment will perform as and replace (Fig 5).

3. Design and Development Process

a. User Profiles

To help with the design of this environment some user profiles were created to list the kind of user that will want to use this environment (**Appendix II**). It potentially would be anyone but the target user base would be:

1. Art student
2. CG Character Modeller
3. Tutor for Anatomy Lecture
4. Curious child

Both theory and practice have been thought about in this design process. Each is as important as the other [Ref 2]. The user will study the content and choose some relevant reference then practice their craft while using the reference.

b. Context of use

The application can be used in a variety of contexts. Students can simply browse through a library of 3D models and use them for art reference or take an instructional course in general or species specific anatomy structure. This can be species that exist now or are extinct. When a student becomes proficient with creature anatomy the student can submit 3D models that can be added to the library. This would act as a reward for the student to fully understand anatomy and their knowledge put to use and immortalised in the library. The students work improving should be reward also.

Aswell as being used at home privately the application can be used in the classroom or in corporate / studio seminars by lecturer as supporting teaching material. The students would become familiar with the environment and can carry on with learning in private using the same environment.

After the research stage had been completed, cycles of development are carried out. Each round consists of developing a prototype to physically test the ideas from the research and design stages, finding what works and what doesn't. The results are then feed back into the design to produce a new round of development and testing. The 3D models selected will be displayed on a phone, tablet or laptop while the student works. In the seminar or lecture scenario the content will be displayed through a projector.

During the first iteration a low fidelity prototype is produced and tested out on a series of test users. The test users were ideally to be target users for this product, but a variety of users were used i.e. age groups and professions.

c. Lo Fidelity Prototype

A paper prototype was constructed to initially envisage the learning environment and test out the key functionality of the environment. Different screens were depicted with menu overlays and content overlays which were played with, experimenting with how the interface would work and content shown. The user is creating something in the real world while using the environment.

- The environment design, at its most stripped down, performs 4 main functions;
1. Searching a vast library of 3D models
 2. Inspecting the model structure, posing it and going through the layers of muscle and skin.
 3. Creating your own custom creature / human.
 4. Going through classes or tutorials teaching anatomy,

d. Main menu screen

. (Fig 6 - 8) shows the main menu screen. Selecting a model from the library and inspecting it. While in 'Inspect' mode the student can cycle through the layers of the anatomy: Bone, Muscle and Skin / Scales / Feathers and rotate and position the 3D model to use as reference while working

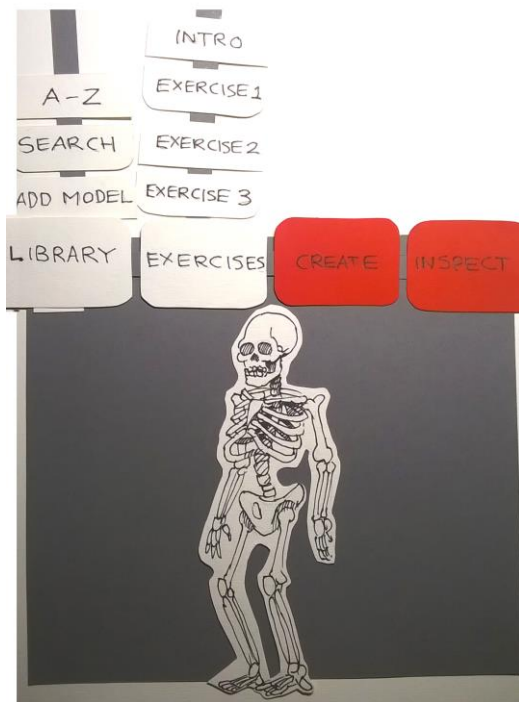


Fig 6. Home Page / Main Menu

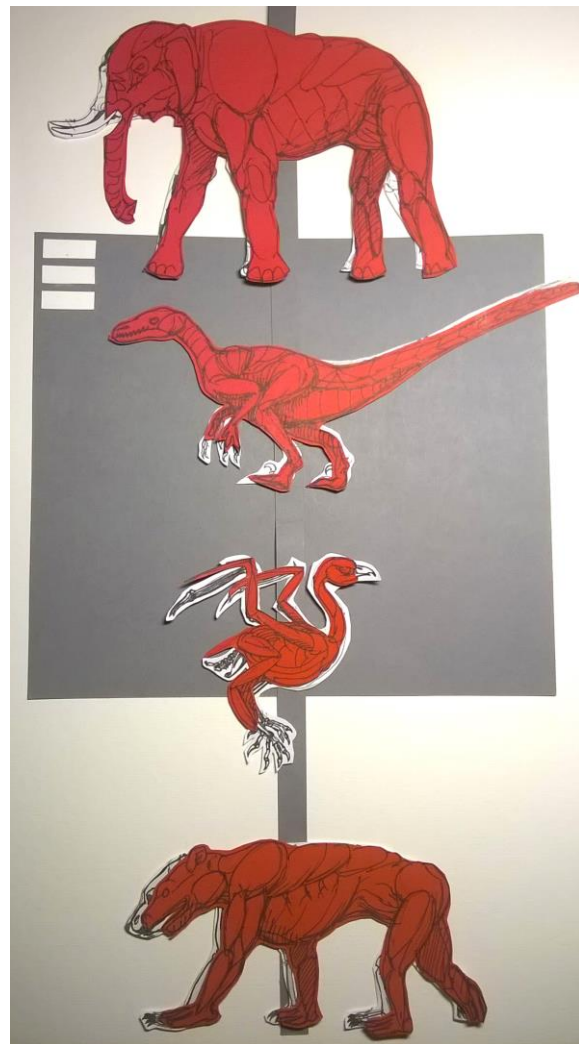


Fig 7. Model Selection



Fig 8. Inspect Model and using the layers

e. The Exercises

When an exercise is selected the student is presented with a step by step walkthrough of the components of certain parts of the anatomy with relevant information. (Fig 9 - 11). These walkthroughs will be listed under the 'Exercise' tab and are designed to give the user a more guided look at anatomy and how the mechanics move and why components are shaped the way they are.

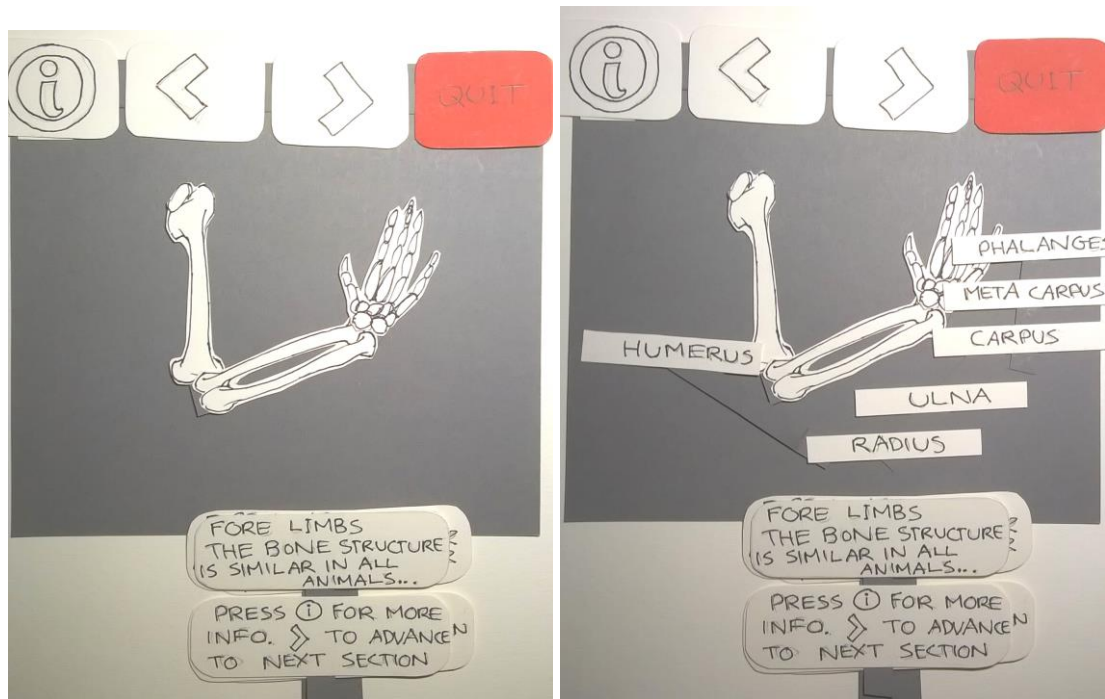


Fig 9. Exercise walkthrough example. Hovering over the items to get the name of the body part

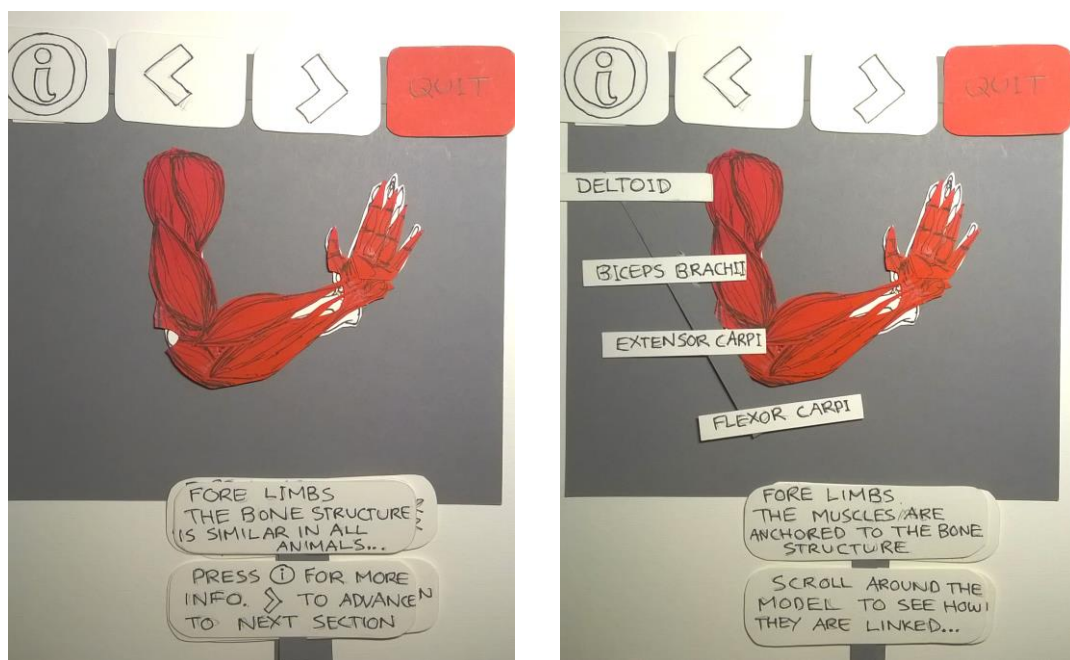


Fig 10. Exercise walkthrough. Learning the names and functionality of the components

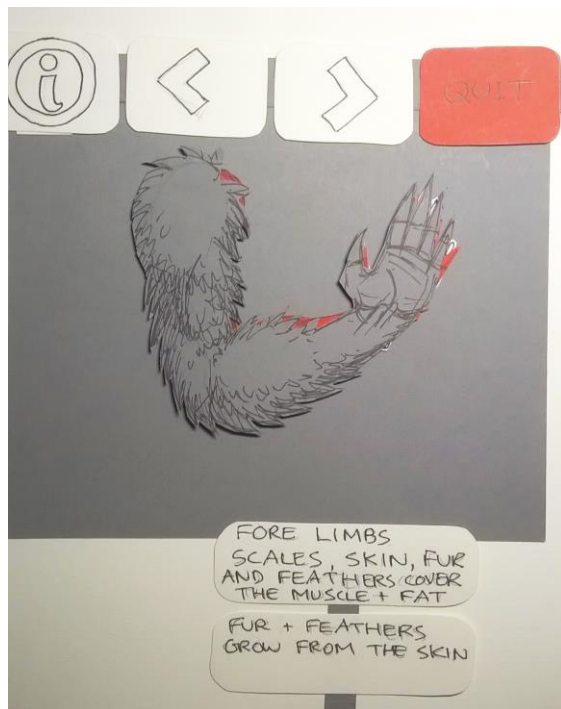


Fig 11. Exercise walkthrough example. Skin / fur etc is shown

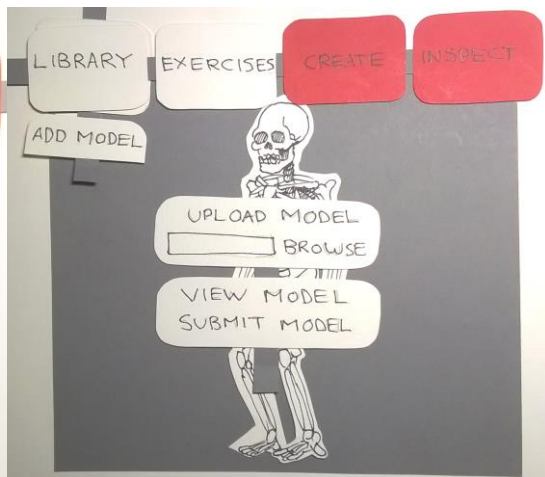


Fig 12. Upload Model to Library

(Fig 12) shows the menu items and fields to upload a model to be submitted for moderation and inclusion to the library.

f. Create Menu

This menu gives the student a chance to use any knowledge gained from the application to create their own creature from the library of skeletal parts and flesh out their design with muscle bundles (Fig 13). If the environment is being used by an Illustrator or a CG Modeller then the student may want to construct a creature or hominid for a project as reference to keep concept designs consistent and to improve the anatomical accuracy of their drawn and sculpted character designs.

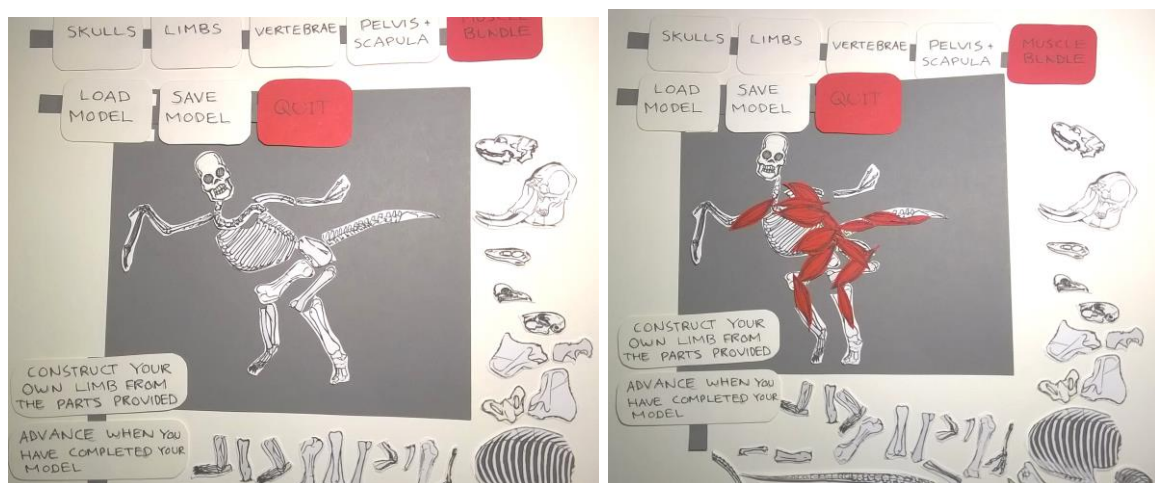


Fig 13. Create menu. Constructing your own anatomical design

The Student can save their constructions locally. This function is not to be confused with adding a model to the application library on the server.

g. Testing the Low Fidelity Prototype

Once most of the components needed to implement the design of the prototype were created a round of testing took place. This will test the usability of the environment and if it functions as a learning environment at all. A total of 7 test users were used. The test users were asked to conduct a series of tasks in the environment and their performance was noted and feedback given at the end. The results were used to feed back into the design for the Mid Fidelity Prototype. The tasks are as follows:

1. Search Library. By name, by scrolling through.
2. Choose an exercise.
3. Create a model and save to the device.
4. Add model to cloud library.

Once the tasks had been completed, each test user was asked a series of questions, (**Appendix III**), and all verbal feedback recorded. The number of mistakes made and a simple rating (1 - 6) of the effectiveness of the environment was recorded. All results are listed in (**Appendix V**). Below are the compiled findings from testing.

h. Qualitative feedback

1. Other users comment on your model when you have uploaded one.
2. Include 'search by name' screen in prototype.
3. Video tutorials for modelling and drawing.
4. Download models.
5. Tutorial instead of exercise. Walkthrough instead of exercises. Classroom instead of exercises.
6. Animate button in tutorial section. Animation element. Set up animations, walk run, jump etc. Animation application to models. Movement / animation to show deforming of muscles.
7. Guide for bone selections in create.
8. Once selected a model, info should show generic / specific.
9. Include help in inspect mode.
10. Add more description about body parts i.e. 'use of tail for balance'.
11. Lighting Environment changes.
12. What about invertebrates?
13. 'Apply' button when selecting creature.
14. There needs to be some kind of test or quiz.
15. < > buttons to go to next animal.
16. Compare bones in classroom.
17. Have skin / muscle /bone buttons instead of current < > buttons
18. Buttons in hierarchical order.
19. Buy / Sell downloads for models.
20. When submit model, moderation is done by community.

i. Best things about Prototype at Low Fidelity

1. Model building.
2. The layers of bone and muscle.
3. The info. Name overlays for bone / muscle etc.
4. The different creatures.
5. Creating / building a creature.
6. Creating / building a creature.
7. Easy to use.

All test users said they prefer using video tutorials on line.
Ages of test users range between 23 - 42. The mean age is 29
Asked if preference was with walk through exercises or free browsing;
3 x exercise 4 x browsing.
The browsing was preferred with some modifications. Overall These results were taken as a rough 50 / 50 split for library or classroom preference.
2 female 5 male

j. Quantitative Results

Mistakes made while testing

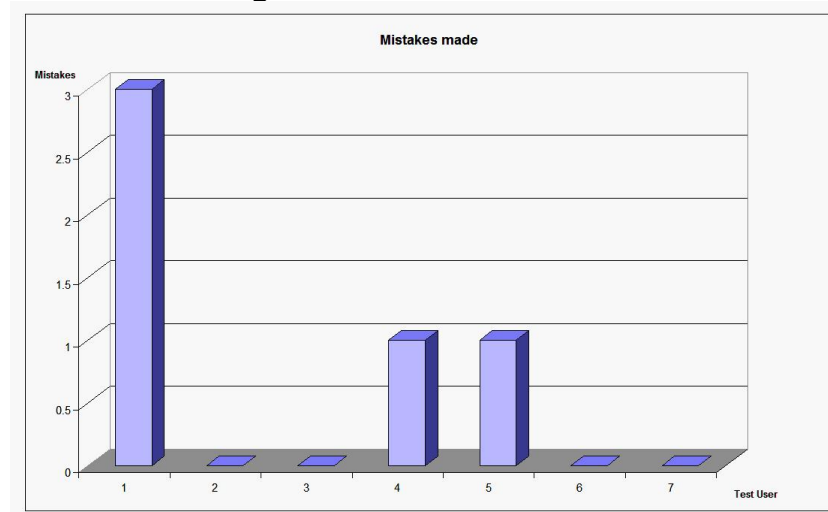


Fig 14. mistakes made by users, low fidelity.

These results were encouraging. 1 user had a bit of trouble and made a mistake for 3 out of the 4 tasks, but over all the average for all test users was **0.7 mistakes per user**.

Rating (1 - 6) for effectiveness of the learning experience

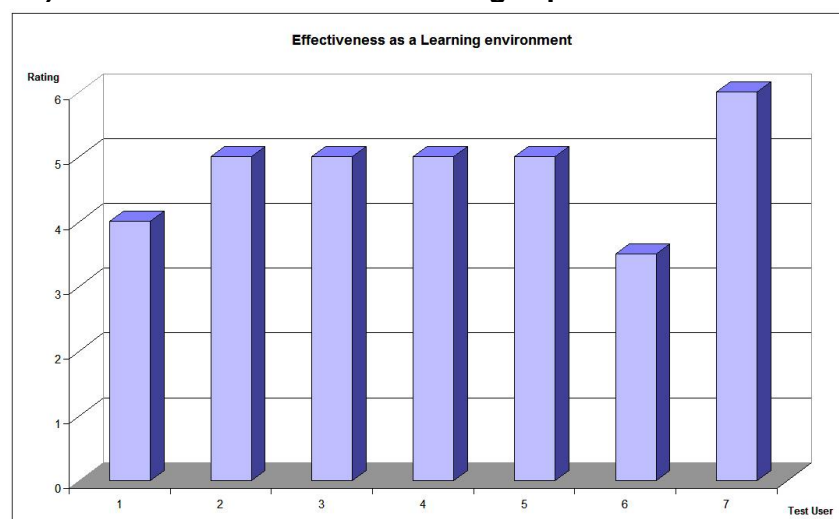


Fig 15. Rating by users, low fidelity.

These results were also encouraging with most users giving an above average score for the environment even though a lot of improvements were suggested. An average score for this round of testing is **4.7 for effectiveness**

Using this data a second round of development is carried out producing a prototype that represents the changes and preferences mentioned by the test users in the previous iteration. A more refined prototype is produced, but still a long way off from the envisioned final design. Ideas that weren't quite working are tweaked or dropped. For example the heading 'Exercises' has been replaced. Most test users thought that was the wrong title for they were not being asked to actually do anything, but this was mainly down to the fact that the exercises hadn't been thought through at all.

k. Mid Fidelity Prototype

The mid fidelity prototype was constructed as a web page to simulate the experience of using the environment design. This seemed like the best quality way to do this in the time given. At this stage it would be quite time consuming and production intensive to produce a 3D viewer that would function as depicted in the lo fidelity prototype design for just test purposes. Instead 2D images have been used and the user is asked to use their imagination and pretend the models on the screen are 3D. Most of the feedback from the low fidelity prototype has been used to create this mid level design.

The application is structured as follows:

I. Main menu screen

The application opens up and presents the user with a selected 3D model and the main menu (Fig 16). All the main tasks are accessed through this main menu. The focus is on displaying the reference model selected with all menus being discreet.



Fig 16. Home Page / Main Menu.

The models are selected from the application library (Fig 17). The learner simply scrolls through the library or selects a model by name. Once a model has been selected the learner can rotate and pose the model as well as unhide / hide the layers of muscle and skin (Fig 18). Feedback from the previous iteration was used to redesign the way the layers are shown.



Fig 17. Model Selection.

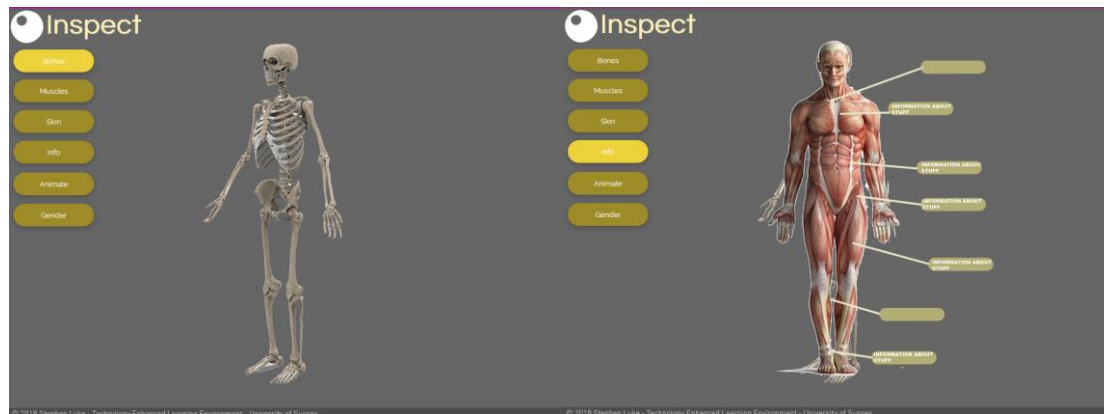


Fig 18. Inspect Model and using the layers.

These models can be used by the learner as reference to improve their work, but if more knowledge was needed or guidance on particular subjects then the learner can select classes which will walk them through knowledge steps on these subjects.

m. Classroom

This part of the application contains a list of different classes on different subjects. The subjects, for example, would be on the similarities between different species anatomy, how muscles deform during movement, why certain body parts are shaped the way they are, modelling and drawing techniques and obscure anatomy quirks. Each class is set up so the user can step through the class at their own pace. The models used in the class are 3D models taken from the library and can be viewed and inspected in the same way as just viewing from the library, but with more information overlaid about the subject, poses and scripted animations (Fig 19). Using the feedback from the previous development iteration, 'Exercises' was changed to 'Classroom' and 'Classes'.

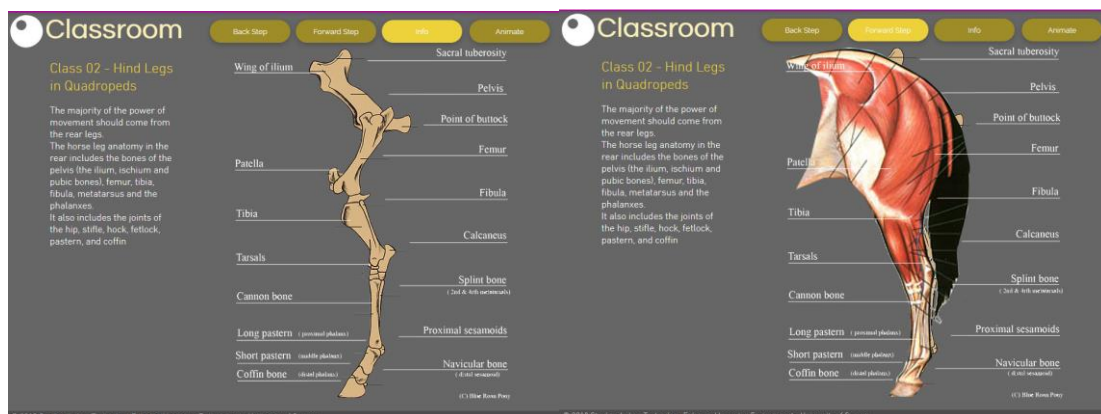


Fig 19. A class in the classroom.



Fig 20. Animated step in a class.

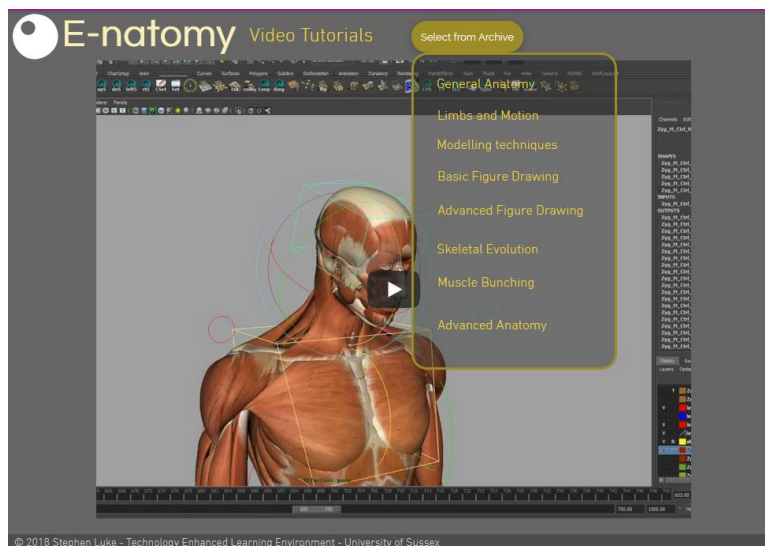


Fig 21. Video Tutorial option selected from classroom menu.

Feedback from the low fidelity prototype suggested that video tutorials were used a lot by users so this option was included in the classroom menu. The learner can choose from a number of specially created videos on a number of anatomy topics (Fig 21).

n. Create Menu

This option has been depicted in its most basic form and still relies on the user using their imagination to create their own custom creature anatomy (Fig 22). It may not be enough to convey the proper potential usage of this feature, but it should simulate the feature better than in the low fidelity prototype. This feature in the low fidelity stage did seem to be popular with users or at least the idea of it did.



Fig 22. Selecting body parts in the 'Create' screen.

Finally some attention has been given to the process of uploading and submitting 3D models by the user to be included in the library (Fig 8). In the final application these models will be moderated and if good enough included in the library. This would create a kind of community. Every model's creator will be credited for their work and thus turn the application into a 'Wiki' that has many contributors. This will also reduce the amount of work that would need to be done by a small team of 3D modellers.

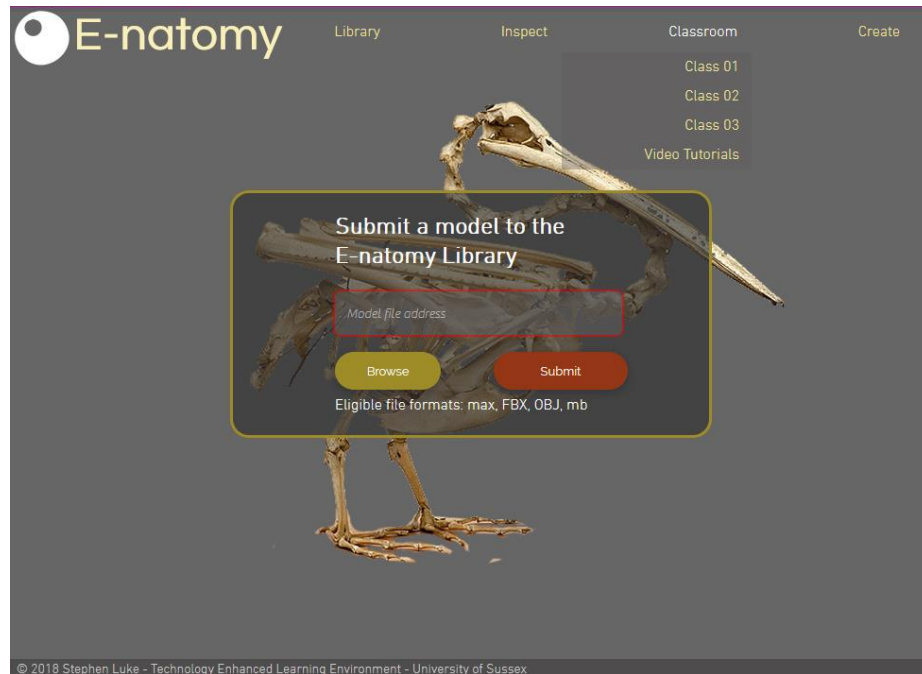


Fig 23. Upload model to the library.

o. Testing the Mid Fidelity Prototype

The test users are selected and asked to perform a similar set of tasks as in the low fidelity test with the addition of 1 task (**Appendix IV**).

Each test user was asked the same set of questions as in the low fidelity test. (**Appendix III**). The test users for this iteration of development were 80% new users and 20% users from the low fidelity iteration. It was decided that a user who had tested the earlier prototype will have prerequisite knowledge that would effect the outcome of next test if they were used again, but it hadn't been decided on whether or not that was important.

The results are logged (**Appendix VI**), and the compiled feedback is shown below:

p. Qualitative feedback

1. Age and body shape , decomposition could be added to models
2. More detailed information and should be able to zoom close into models.
3. All buttons need to look the same and the font should be customisable.
4. Classes that makes sense.
5. Home button need to be more obvious.
6. Download 'create' model
7. Put in environment
8. Change colour of skin
9. Dinosaurs in the library
10. All learning styles covered

q. Quantitative Results

Mistakes made while testing

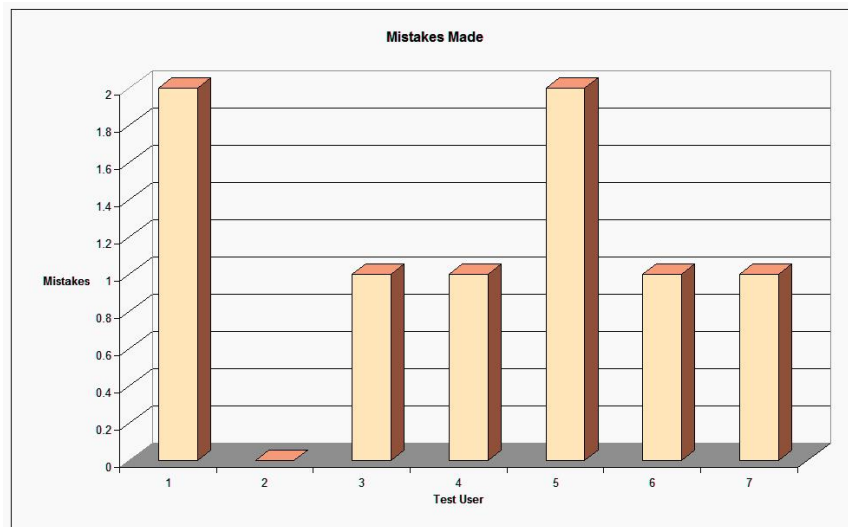


Fig 24. mistakes made by users, mid fidelity.

More mistakes seem to have been made this time round. The average number of mistakes made by this batch of test users is **1.14 mistakes per user**.

Rating (1 - 6) for effectiveness of the learning experience



Fig 25. Rating by users, mid fidelity.

From first look the results seem very similar to the previous ratings. The average rating for the environment this time round is **4.9**. This is slightly higher than the previous rating. **3.2% higher**.

r. Best Aspects of the Mid Fidelity Prototype

1. library x 5
2. The animation
3. the create screen

100% users said they prefer video tutorials. .

30% of users use text based as well.

This round of testers were 1 female and 6 male.

The mean age of the user group is **31.4 years old**.

The preference ratio between browsing the library and going through the classes is;

Library = 5 Classes = 4.

Still about 50 / 50 with Library slightly more popular.

Having 3 types of learning; free browsing, video and stepped classes seemed to be good, but the classes need a lot of attention specially in the type of content and how that content is conveyed.

4. From Theory to Design

The design is influenced by behaviourist theory because the learner is stimulated with the visual models and the response is to draw or sculpt better. The reward is improving the learners work quality. It could be influence by cognitive theory in the way that it supplies learning in multiple ways. Video, text based tutorials and free form experimenting and inspection. This is giving the learner a choice of how to absorb the information depending on their own particular cognitive needs. This can be observed and the best or most popular choice of input can be logged, but mostly, this environment is Constructivist. The learner builds on the knowledge they already had. Once they have learnt a few things about a particular species they may move on to inspect another species and see similarities in the anatomies. This is another level. Then they may try to build their own creations through using the knowledge gained while studying the similarities between species from the previous level. Once they have practiced with building different body shapes they may want to simply change the colour and textures of the skin of their designs to see what works and what doesn't once they have become comfortable with proportion and form.

The constructionist aspect of this environment is that the learner is absorbing knowledge while they are sculpting or drawing so the information they are taking on they are applying immediately to their work and putting into practice.

This environment definitely works as Constructivist and should always work as Constructionist because it's all about practising the knowledge gained, but a different approach is needed for the classrooms. This area of the environment is a bit confused and needs addressing. It is currently following along the lines of a scripted sectioned tutorial where the learner can step through the sections in their own time but there is no reward or test at the end of the tutorial.

There probably isn't a lot of intrinsic motivation for the learner to use the classroom. Overall motivation to use this environment is extrinsic because the user improving their artistic creations would be the main driving force here and this environment should help achieve that. The user creates their own goals rather than the environment creating them and all feedback, critique and recognition of their understanding comes from their peers and project managers who look at the art and modelling produced.

5. Innovative Interactions

I think it improves on traditional teaching environments like life drawing classes, anatomy books and the applications researched earlier in this assignment because it provides an instant and accurate solution to modern day art professionals needs. The hardware is widely available so acquiring the software and setting up a personal creative studio space is very achievable and more convenient than booking and going to life classes. Also this environment can be used as supporting material quickly and efficiently by a tutor or speaker.

A tutor could probably create their own stepped classrooms in the application and record them and play them back like slides in the lecture.

There is no innovative hardware involved, but being able to adjust any reference model while working could be deemed as innovative by some that are not familiar with 3D computer graphics.

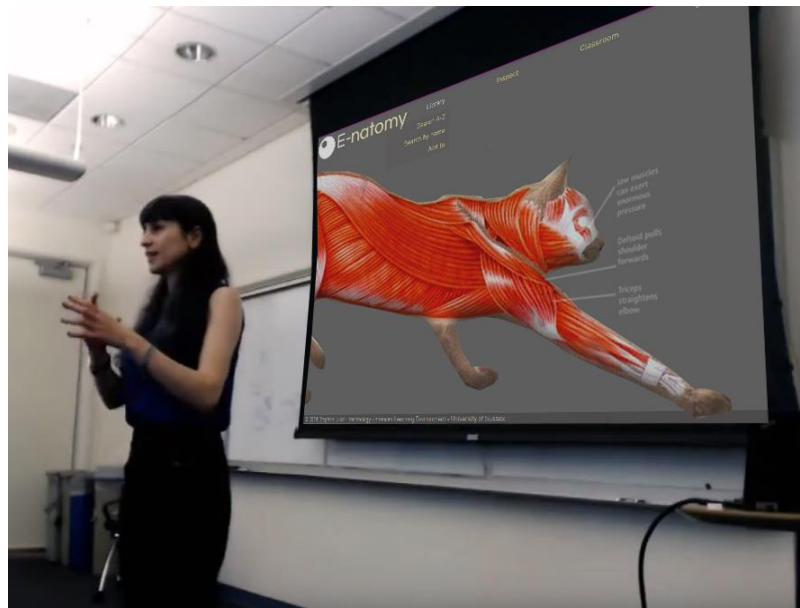


Fig 26. Mock up image to demonstrate a lecture scenario

6. Reflections on the Design Process

The environment idea was fleshed out, and on each design pass it was amended by adding the best ideas that test users had come up with previously and changing or deleting the ideas that most users said they didn't like. This process is definitely a good way to obtain and implement feedback, but all the test users in these sessions were from different backgrounds and some were not even interested in anatomy so the results and suggestions are very mixed and maybe not what would be needed by the target user. Target users would need to be found with increased selective test user recruitment.

A few of the users were CG professionals and artists so their feedback was of particular interest. The classroom part of the environment was a generic walkthrough system with no actual thought through content. This proved in 2 iterations to be not enough to convince users or the developer that there is anything to learn even though all stake holders like the idea of the classrooms. A proper tutorial would need to be constructed to near finish to test this aspect of the environment or maybe just dropped. More emphasis needs to be paid to the way in which the subject is conveyed to the student than the technical aspects of the technology.

The 'Individual motivations' mentioned by Malone and Lepper [Ref 1] are implemented in the design process. Curiosity is created by the content in the extensive library and the ability to strip away or add layers to the models. The learner is in total control of the experience, but there are uncertain outcomes. The learner is using the environment to create a piece of artwork. There are no certainties to the quality of the output. This work can be satisfactory or a total mess depending on many other factors than simply the learners anatomy proficiency.

7. Individual Reflection

The main problem space in this assignment is: 'can a learning environment using technology be designed in a way that it can be applied to any subject?' To test this fully would be to go through the process with a number of topics and see how the environment stands up, but this would take much more time to carry out. Different topics will have students with different motivations and different goals. Teaching life guard training would probably require a totally different system to learning Chinese. Because this cross topic testing hasn't been carried out the goal has not been achieved yet.

Going through this process has brought to mind all the types of technology used in education in the past and particularly the ancient past. One of the most advanced and amazing forms of technology from the past that would be used extensively in learning would have been 'writing'.

The rating for the prototype as an effective learning tool seemed to be quite good from test learners, but the testers were not actually tested on knowledge that they could have learnt using the prototype or were they asked to actually draw or model something using the environment. This should actually be implemented on the next iteration.

8. Future Evaluation

There would need to be a lot more passes needed to establish if this design direction is correct or not. The next iteration would be to implement some 3D into the prototype and have some of the tools available to manipulate and pose a model. At least one well structured classroom tutorial sequence should be built and completed. The test users should actually be able to use the technology as reference and do some drawing or sculpting and the work logged as an example. Then the test user would be asked to comment on the experience and state whether they feel that they had learnt something or not. There wouldn't be a set of tasks to carry out this time, only the completion of a piece of artwork finished to their own satisfaction using the environment. The user would just be left to their own devices in their own time.

Because each test session may take 30 to 45 minutes depending on how much time the test user will want to spend being creative, the amount of test learners to use would be about 10. Similar questions would be asked of the test learner as in earlier iterations, but with more emphasis given to 'Do they think they are learning something?'. Maybe a simple test after the session could see how much technical data, i.e. bone and muscle names, were remembered by the user. This test would purely be for evaluation purposes and would not be a feature of the environment.

Their work produced while using the environment would probably be the most important data, but getting their feelings and suggestions through questioning is important also to really see if they are learning anything or the environment is just a toy.

The environment is a success as a learning environment if it actually helps the users work improve, but has the test learner absorbed any technical information about anatomy and did they actually want to know or not? Can a creative ability be rated in the same way as the speed in which a calculation can be performed on paper or a lawnmower motor being assembled correctly or the amount of correct questions in a quiz on geology?

One other test that would be good for this prototype in future evaluations would be to use it in a seminar projected on a screen and a tutor use it as supporting material in an anatomy class. Afterward the students attending the class would be questioned on how they found the experience and did they learn anything useful?

9. Reference

- [1] - Malone, Thomas W. Lepper, Mark R : (1983). Making Learning fun: A Taxonomy of Intrinsic Motivations for Learning. Stanford University
- [2] - Ertmer, Peggy A. Newby, Timothy J (2016). Learning Theory and Technology: A Reciprocal Relationship. John Wiley and Sons Inc.
- [3] - Ken Hub: <https://www.kenhub.com/landing/anatomy-learn?>
- [4] - Anatomy Learning: <http://www.anatomylearning.com/en/>

10. Appendices

[I] Topics, Existing Environments and Exercise 2 tests

1. Paleobiology and archaeology learning.

2. Fossils / Natural History.

<http://www.kidsdinos.com/dinosaur-games/dinosaur-memory>

<http://www.nhm.ac.uk/take-part/dippy-on-tour/dinosaurs-and-birds-learning-resources.html>

Why? I like the links between different species anatomies and behaviours

3. Planet / Rock and Mineral exploration.

Why? I think its good to expand our research and knowledge of the universe

<https://spaceplace.nasa.gov/all-about-venus/en/>

3. Planet / Rock and Mineral exploration.	Using Web GL and 3D in browser to help teach kids about our solar system
Target audience?	Kids aged 6 to 18
Why this issue?	Children can absorb galactic concepts quicker if immersed in a 3D world
problems with the way it is currently taught?	A lot of data to absorb and can be accessed in a more fun way than say how NASA do it on their website. Although I do like the NASA website and think it is informative.
New tech to accomplish solution?	No just browser and end user graphics card
What difference will this make to the way its taught?	Put the student into the solar system virtually and help them understand the immensity of the distances between the planets. Information can be asked for from the computer instead of listed out in long articles,
Why will method improve teaching?	The database and software can be used by speakers in lectures and seminars as supporting material or by students on their own going through personal sessions at their own rate.

4. Programming (Node based).

<https://www.codecademy.com/>

5. Anthropology

6. The 'Wiki' style of constructivist learning.

Why? Having millions of people adding to a knowledge base is good, but a lot of moderating and citation is needed.

7. Modeling and simulation environments.

'Safety Stock' example style of animated tutorial followed by a simulated scenario puzzle to solve or a simulated mechanic to recreate.

Why? To teach physics in a hands on and practical way.

8. Medicine / First Aid

<https://www.e-lfh.org.uk/programmes/>

Why? Important that everyone should have some sort of medical training and first aid.

8.Medicine.	
Target audience?	Anyone over age of 16
Why this issue?	Important that everyone should have some medical training.
problems with the way it is currently taught?	
New tech to accomplish solution?	
What difference will this make to the way its taught?	

9. Anatomy

<https://www.kenhub.com/landing/anatomy-learn?>

<http://www.anatomylearning.com/WebGL/browser.php>

'I Muscle'

'3D Anatomy for the Artist' – Catfish Aniamtion Studios.

Why? As an artist, I think about anatomy a lot. I have been asked first hand about developed applications for mobile devices which show 3D anatomy for reference and tutorials

9. Anatomy for creatives.	A technique of teaching Anatomy from the bones outward using 3D models stored in a database as visual aids and used at seminars and online tutorials through a browser or application.
Target audience?	Young Adults / professionals
Why this issue?	It's a topic I am interested in and I know people have been looking for it in different creative industries to help with their character design etc.
problems with the way it is currently taught?	<p>It is taught quite well, but 3D graphics can be utilised more.</p> <p>There isn't a cross species anatomy application. Its mainly about human anatomy for medical professionals.</p> <p>Very techy. Not many for use as artistic reference.</p> <p>Video Tutorials used a lot, but not enough interaction while learning (during the course).</p>
New tech to accomplish solution?	Not really anything new, but possibly include the facility to use 3D printer to make figures to use as art reference.
What difference will this make to the way its taught?	Can physically see anatomical parts and use to help with visualisation techniques.
Different teaching method proposed	<p>Draws on huge database of 3D models and the system allows the models to be viewed from skeleton to skin / feathers etc.</p> <p>Species are catagorised with family trees, genus, kingdom etc..</p>
Why will method improve teaching?	The database and software can be used by speakers in lectures and seminars as supporting material or by students on their own going through personal sessions at their own rate.

[II] User Profiles

1. Art student

21 years old. Studying at University. English is second language.

Can draw, but wants to develop anatomy skills more for realism and improve coursework as well as personal work. Current anatomy knowledge is very limited. Would like to be able to 3D print models to use as reference

2. CG Character Modeller

32 years old. Works for animation and production company creating 3D characters.

Needs to be able to create realistic and believable stylised characters for animation. With proper complex understanding of anatomy and good reference, the user should be able to create new fantasy creatures quickly and sometimes on the fly. Has some anatomy knowledge, but wants to perfect skills.

3. Tutor for Anatomy Lecture

43 years old. Teaches anatomy in different universities and for private production companies.

Needs supporting material, mainly projections / slides, for seminars and lectures. An interactive display of anatomical content would really support the lecture material taught and the students can use the same software on their own devices outside lectures. Has very good anatomy knowledge, but wants to perfect knowledge and see correlations between species.

4. Curious child

12 years old. Young and curious. Middle school attendee. Loves animals and science. Always wanting to know about things and likes to test out technologies and research.

[III] Questions for Feedback

About the user

1. Do you have an interest in anatomy?
2. Would this kind of environment be of use to you if you wanted to learn anatomy?
3. Do you use online / computer based tutorials or learning material?
4. Would you be prepared to pay for an application like this or would you expect it to be free?
5. What age are you?

Qualitative

6. How deep into anatomy would you expect the application to delve?
7. Do you think including extinct creatures is a useful addition or irrelevant?
8. Can you navigate easily to the correct sections?
9. Is it more interesting to just browse the model library in your own time or to go through the tutorials?
10. What do you think is missing from the environment?
11. What is the best thing about the environment?
12. Do you feel like you are learning something and motivated to re use the environment?

Quantitative

13. How many mistakes made while using the environment?
14. On a scale of 1 to 6 how effective is the environment as a learning experience?

[IV] Task list

1. Search Library. By name, by scrolling through.
2. Inspect model, look at layers.
2. Choose an exercise.
3. Create a model and save to the device.
4. Add model to cloud library.

[V] Lo Fidelity Prototype Results

Test User 01

Question	Feedback / Personal
1	Yes
2	Maybe
3	Yes, Video tutorials.
4	Free for fun interest. Paid for more professional.
5	23
Qualitative	
6	Would prefer simple, not very deep into the subject.
7	Yes, useful.
8	The navigation is ok.
9	The exercises are good for learning more.
10	Other users comment on your model when you have uploaded one. Include 'search by name' screen in prototype. By name
11	Model building.
12	Clearer goals
Quantitative	
13	3
14	4

Test User 02

Question	Feedback / Personal
1	Casual Interest
2	Yes
3	Yes, mostly video.
4	Free. Pay for more professional application.
5	25
Qualitative	
6	Existing level is good. Option to go deeper would be good.
7	.yes
8	Yes
9	Browsing is better than tutorial function.
10	Video tutorials for modelling and drawing. Download models. Tutorial instead of exercise. Animate button in tutorial section. Guide for bone selections in create. Once selected a model, info should show generic / specific.
11	The layers of bone and muscle.
12	Yes.
Quantitative	
13	0
14	5

Test User 03

Question	Feedback / Personal
1	Yes. Has background in anatomy.
2	Yes
3	Yes, prefers video and exercise.
4	Free.
5	24
Qualitative	
6	Existing level is good.
7	Yes
8	Yes, Made sense.
9	Tutorial is more interesting.
10	Animation element. Set up animations, walk run, jump etc... Walkthrough instead of exercises.
11	The info. Name overlays for bone / muscle etc.
12	Yes.
Quantitative	
13	0
14	5

Test User 04

Question	Feedback / Personal
1	Yes
2	Yes
3	Yes, online / textbooks 50/50.
4	Willing to pay if you get extras.
5	23
Qualitative	
6	Would like full detail if possible.
7	Yes
8	Yes. Upload model was hardest to navigate to
9	Browsing is better (with info).
10	Include help in inspect mode. Add more description about body parts i.e 'use of tail for balance'.
11	The different creatures.
12	Yes until the creatures have been explored.
Quantitative	
13	1 -add models
14	5

Test User 05

Question	Feedback / Personal
1	Yes absolutely
2	Yes
3	Yes, youtube videos.
4	Trial first, maybe pay later.
5	42
Qualitative	
6	As is otherwise it becomes a medical application.
7	Yes
8	Yes. Maybe customisable.
9	Browsing is better.
10	Lighting Environment changes. Animation application to models. What about invertabrates?? 'Apply' button when selecting creature.
11	Creating / building a creature.
12	Probably would. The free form creating element may confuse learning.
Quantitative	
13	1
14	5

Test User 06

Question	Feedback / Personal
1	Yes
2	Yes
3	Yes, videos.
4	Free
5	23
Qualitative	
6	Go deeper if paying - Unlock veins and organs.
7	Yes for artists, not if user is doing medical training.
8	Yes. Quite logical
9	Browsing is better.
10	There needs to be some kind of test or quiz.
11	Creating / building a creature.
12	Would learn more with a quiz.
Quantitative	
13	0
14	3.5

Test User 07

Question	Feedback / Personal
1	Yes
2	Yes
3	Yes, videos.
4	Yes to pay, depends on quality
5	41
Qualitative	
6	Would like Super Deep but doesn't expect it.
7	Yes for artists, include fantasy creatures.
8	Yes.
9	Tutorial if showed specific animals.
10	<p>Movement / animation to show deforming of muscles.</p> <p>Classroom instead of exercises.</p> <p>Compare bones in classroom.</p> <p>< > buttons to go to next animal.</p> <p>Have skin / muscle /bone buttons instead.</p> <p>One buttons in hierarchical order.</p> <p>Buy / Sell downloads for models.</p> <p>When submit model, moderation is done by community.</p>
11	Easy to use.
12	Yes.
Quantitative	
13	0
14	6

[VI] Mid Fidelity Prototype Results

Test User 01

Question	Feedback / Personal
1	yes
2	yes
3	50/50 written / video
4	Yes if not expensive
5	22
Qualitative	
6	Enough as is
7	It makes it more interesting.
8	Quite straight forward
9	Exploring library
10	Nothing needs to be added
11	Library
12	Yes, it is informative.
Quantitative	
13	2
14	5

Test User 02

Question	Feedback / Personal
1	yes
2	Yes, it is like a wooded mannequin
3	Yes. video
4	Yes, if I regularly need to draw
5	29
Qualitative	
6	For an artist as is is good.
7	Yes
8	Yes straight forward
9	Classroom is helpful to show how an artist can depict the anatomy
10	Age and body shape
11	Library is good if it is huge
12	Yes, using the classes. It asks you to analyse more. Comparing proportions.
Quantitative	
13	0
14	6

Test User 03

Question	Feedback / Personal
1	Partial
2	Yes
3	Yes. Video - rarely use text
4	Maybe on subscription
5	23
Qualitative	
6	Organs and arteries
7	Yes
8	Yes
9	50 / 50
10	Age and decomposition

11	Library
12	Yes
Quantitative	
13	1
14	4.5

Test User 04

Question	Feedback / Personal
1	Casual
2	Maybe
3	Yes. video, prefer text based
4	Expect to pay
5	24
Qualitative	
6	Maybe organs. depends on what the artist wants to draw.
7	Yes, depends on the artist.
8	Yes, home button was intuitive
9	Library is more useful
10	More detail information zoomed into
11	Browse library
12	maybe
Quantitative	
13	1
14	4

Test User 05

Question	Feedback / Personal
1	No
2	Yes, if user wanted to learn
3	Yes, video and text
4	Depends on quality. Free for fun, pay for professional
5	32
Qualitative	
6	Depends on target audience.
7	Yes
8	Options at top is good. Side buttons to manipulate models is good,
9	Library is good for casual. Class is good if user wants to learn more
10	all buttons need to look the same. font customisable.
11	Dinosaur addition is the best bit. All learning styles is covered.
12	yes
Quantitative	
13	2
14	6

Test User 06

Question	Feedback / Personal
1	Yes
2	Yes
3	Yes, videos.
4	Free, pay to download
5	47
Qualitative	
6	As is good.

7	Yes
8	Yes. Easy,
9	Library
10	Classes that makes sense. home button need to be more obvious
11	Library
12	Yes
	Quantitative
13	1
14	4

Test User 07

Question	Feedback / Personal
1	Yes
2	Yes
3	Yes, videos.
4	Trial then pay if use a lot
5	43
	Qualitative
6	As is
7	Yes. shows evolution
8	Yes
9	50 50
10	Download 'create' model Put in environment Change colour of skin
11	The animation. the create screen
12	Yes. Comparing links between species
	Quantitative
13	1
14	5

[VII] Consent Form

Technology Enhanced Learning Environment Module Project

RESEARCH ETHICS: PARTICIPANT CONSENT FORM AND INFORMATION SHEET

Project title:

Evaluation of TELE prototype..

Project information:

The aim of this project is to evaluate a technology enhanced learning environment designed to teach artists and cg professionals anatomy to further their knowledge and improve the level of their work.

The tests should take about 30 – 45 mins and the data will be used for analysis on this project at Sussex University.

**Please cross
out as
appropriate**

- | | |
|---|----------|
| 1. I confirm that I have read and understand the project information and have had the opportunity to ask questions. | Yes / No |
| 2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason. | Yes / No |
| 3. I agree to take part in the above study. | Yes / No |

Name of Participant

Date

Signature

Contact details:

Researcher: Stephen Luke (sl578@sussex.ac.uk)

Supervisor: Dr Judith Good (J.Good@sussex.ac.uk)