UNIVERSITY OF THE WEST of SCOTLAND

UWS

Serious Games (COMP10010)

A Literature Review of Serious Game for Phlebotomy Medical Training

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Abstract

Background:

The act of phlebotomy, medically trained and professionally performed by the phlebotomist, but mostly conducted by nurses at local medical centres and hospitals. These nurses are not properly trained throughout there degree of study, and learn these skills when out at work, this is where a phlebotomy training game would advise with further learning.

Methods:

In the testing phase this paper arranged for medical students from two classes (54, with a 25 to 29 split) at the same level at the University of the West of Scotland to be participants in testing. This test started with one of the classes (C1) having an unspecified 10 item survey addresses demographics, game play experience and attitudes towards phlebotomy training using game play mechanics before they tester the prototype serious game, instructions on how to take blood, this short instruction period was to see if prior knowledge would help. The other class (C2) going straight into the testing of the serious game.

Results:

The result shows that out of the two classes with 54 participants, more of which were female (84%) the rest male. Who were split in to two classes, Class 1 participant, who received instructional help before play testing, and Class 2 who went straight into the play testing. That out of 100% on their first paly through of the game, mixed with the score and time, that the average score was in the 65-70% range, with Class 1 having an average of 56% and Class 2 having an average of 68%. This percentage does not accurately portray that those who were instructed before did better, as the questionnaire shows that more of the Class 2 had prior knowledge to phlebotomy than Class 1. The full result is details in the accompanying section.

Conclusion:

The main conclusion is that the data obtained through the investigation of testing the prototyped serious game and questionnaire answered after play testing, shows some support towards the development of serious games along with comparisons to similar studies for the use in phlebotomy and medical training.

Keywords:

Serious Games, Phlebotomy, Virtual Simulations, Interactive Learning, Learning-Centred Teaching.

List of Abbreviations:

TKA	Total Knee Arthroplasty
UI	User Interface
NEAT	Neuroevolution of Augmenting Topologies
NN	Neural Network
C1	Class 1
C2	Class 2

Table of Contents

Figure Table

1. Introduction

Serious games usually have educational aims or health related aims other than pure entertainment. Mainly, these games would be classified for e-learning and medical applications. Whilst, recently the uses of serious games design and development in the medical field have focused on the health benefits of the intended users. The purpose of this paper is to aim at the use of serious games in education and training of learning medical students. To pursue this goal, this paper will identify and review the available literature on Serious Games for training in the medical field and classify the research found according to the learning outcomes associated with them. A second aim would be to create a serious game for students in the field of medicine, focusing on the task of taking blood. This serious game will look at the current conventional learning methods and ways to improve and further grow the serious games in medicine region. Whilst looking at serious games and their role in the medical field, this paper will look upon the current measures for training medical students and their experience with these situations.

2. Previous Work

When reporting on serious games, a key question is what the concept itself means. Even a brief look at current literature reveals that there are many definitions available. Many of these papers agree on a main meaning that serious games are digital games that have a purpose other to that of entertainment. Serious games can be applied to a wide area, such as education, healthcare, military, and government. The use of serious games as a learning tool is not a new concept. Many digital games have been used or created for learning social, physical and psychological skills. When looking at the overview of serious games, Ben Sawyer, co-founder of the Serious Games Initiative, stated that today's "serious games" is a serious business. The serious games market is said to be worth at $20 million, with overall digital gaming at $10 billion per year industry (van Eck, 2006). Serious games are becoming even more popular with the global education and training market, as stated by Michael and Chen (2006) "by 2008, 40 percent of the U.S. companies will adopt serious games in their training efforts". A second question to ask when looking at previous literature, is that of concerns of claimed positive effects of such games, or applications from sometimes overlapping areas such as safety, cost, time in real world scenarios (Corti, 2006; Squire & Jenkins, 2003).

The technology innovations for serious games, such as virtual reality simulations and augmented reality are increasing the e-learning applications, with consistent improvements within the learning outcomes. These have already played an increasing role in surgical residency training programs (Sabri et al., 2010). This paper looked upon a use for "serious games for knee replacement surgery procedure education and training". There overview of a series game would be to server as a memory aid to students learning the procedure, and to be used in conjunction to the traditional learning. With a goal for the user to complete successfully the TKA procedure. This would appear to be closer to a simulation than an educational game, but what takes it from that to a serious game, is the multiple sub-game features. Being small tasks related to the step they are currently performing, with an example of multiple choice questions randomly selected from a pre-defined list to allow the user to gain further points. The hypothesized outcome of this research was that by learning TKA in a first-person shooter gaming environment would give a much better understanding of the procedure than traditional learning, and that the user who would have been pre-trained in simulators will perform technically better due to a greater understanding of the cognitive process. This paper by Hamed Sabri and others, holds a wide range of useful information towards the use of serious games and research towards the medical education field.

Considering the creation and implementation of serious game based learning for medical education and training in this paper, it would make non-positive growth in research material if those who are targeted do not have a good attitude towards game based learning. Although in Frederick W Kron's research paper on medical student's attitude towards video games and related new media technologies in medical education (Kron et al., 2010). States that from surveys towards medical students from two American universities, addressed game play experience and attitude to using new media technologies in medical education. The results of 217 medical students, with 53% female, liked the idea of using innovative technology to enhance medical and healthcare education, with 98%. Many of which felt that education should make better use of technology, and that 80% said, video games can have educational value. Overall, this showed that a small group of new medical students, many who did not play video

games, Highley favoured views about the use of video games and related new media technology in medical education. This information greatly heightens the consideration for creating and implementation of serious games into the medical healthcare education, even with many medical professionals still have outdated views compared to the new upcoming students.

Currently the medical training for taking blood is conducted by the phlebotomist, a medically trained professional who draws blood from patients, for clinical or medical testing, transfusions, donations, or research. Some research and experience has shown that not all blood draws are conducted by he trained phlebotomist, but by nurses and sometimes doctors (Simundik et al., 2015). This paper surveyed the education and training of phlebotomy in 28 European countries, which found that 7 of the 28 countries have strict national guidelines, which state that the phlebotomist is the only medically trained professional who can draw blood. As this is a small amount of just 28 countries what have strict rules on who can and cannot draw blood, and with the lack of training to nurses who end up conducting these tasks, the use of quicker teaching and performing may be required.

The phlebotomist currently learn by using a training device, there are many different type of devices depending on state or country. These devices all have the same standard features, including a core member that incorporates a network of channels, where resilient tubing is placed to form artificial veins and arteries. This tubing contains a fluid reservoir disposed at an end of the device for maintaining the tubing full of fluid. This US patent for the most commonly used training device shows how the device is used for operation (Bloom and Ellen A, 1997). Fig.1 shows the original patented image for the training device, this clearly show how the device would strap onto an arm and where the tubes which would be full of liquid would be situated. These tubes are positioned in the proper place of an actual human arm, without he risks associated with puncturing living tissue,

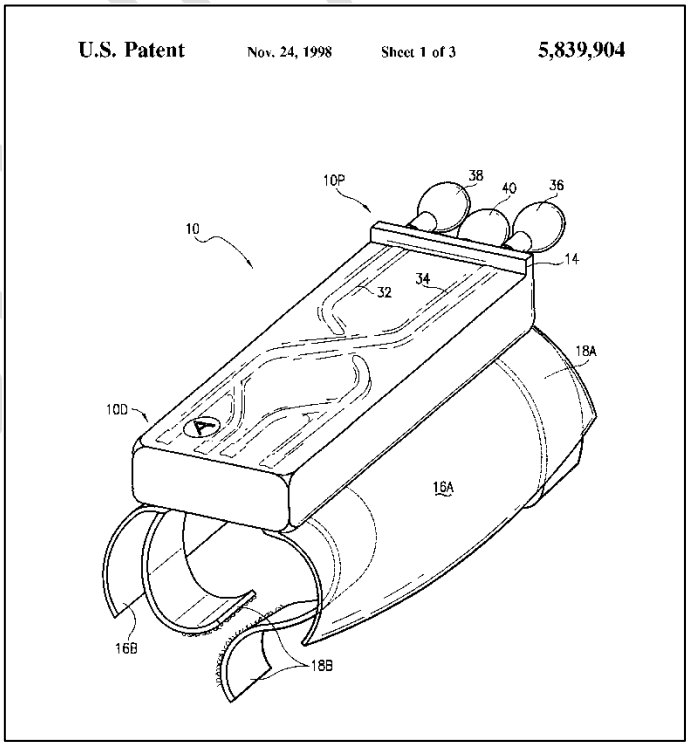

Fig 1. Phlebotomy Training Device (Bloom and Ellen A, 1997)

Once this device has been used the tubes would then be discarded and replaced with new tubes and skin layer. As there would be many medical trainees learning on these devices, the cost of materials would substantial increase after using this device multiple times.

The use of a simulated training device would increase the reusability and reduce the long term cost upon the state, school, or following body that supplies or pays for equipment and materials. In Scerbo's study on the efficacy of medical virtual reality simulators for training phlebotomy (Scerbo, Schmidt and Bliss, 2006), they look to compare the effectiveness of a virtual reality simulator for training phlebotomy with that of a more traditional approach using simulated limbs. The method Scerbo used was to have a group of 20 3rd year medical students, who were trained under one of the two methods and had their performance assessed with a 28-item checklist. The instrument conducted the 28 specific steps that would provide a score in key areas of preparation, insertion, withdrawal, and the overall performance. They modified the technology so that the study would include several rating scales so that the user performance could be assessed in a quantitative manner. They rated the instrument with a score of 0 to 88 points, with higher reflecting in greater performance. The procedure that all participants were asked to complete, started with a background questionnaire. Thereafter, participants were shown an instructional video about phlebotomy, half of the participants were selected randomly to complete the simulated arm, and others on the virtual reality arm. However, Scerbo says that because of issues with participants scheduling, the groups were split 9 in the virtual reality arm and 11 in the simulated arm, with any of whom had phlebotomy training or education being slit between these two groups. This shows that there are many contribution facts that can cause results to be weighted towards one side, being any previous knowledge or sheer chance of luck. In the procedure all participants performed the phlebotomy pretest on the simulated arm, with 2 weeks afterwards consisting of training. The participant then under went more training and testing with their group on the selected device, upon completion of training, all the participants performed a post test on the standardized simulated arm, their performance was assessed with their pretest with the same instrument. In the results, Scerbo details the full procedure starting with the total scores from the pre-and post-test assessments of each participants. The scores were computed to show in the form of the following table (Table 1).

TABLE 1: Mean Assessment Scores on the Pretest and Posttest for Both Groups on the Full Procedure and on Common Steps

	Full Procedure		Common Steps	
	Pretest	Posttest	Pretest	Posttest
Simulated arms	60.82 (8.6)	82.91 (3.5)	36.91 (6.5)	49.1 (2.3)
VR system	63.22 (13.8)	68.67 (7.2)	37.78 (8.6)	42.22 (5.3)

The results of the analysed data showed that between the pre-and-post test scores was significant only for the participants who worked with the simulated arm, and there was no significant difference between the two participating groups. He concluded that the participants trained with the simulated limbs, and a detailed comparison of the two systems showed several functional and physical differences that may explain these findings. This gives very useful information towards the advantages of using simulated training and the possibility of becoming a serious game.

The use of virtual reality is still stated as new technology in the medical field, with ever growing studies and programmes to be used for training and further learning. In Wandell's study on using virtual reality simulated training in phlebotomy (Wandell, 2010), looked to the effectiveness of a virtual reality simulator compared to a traditional method of teaching. The method used was 25 participants in a 5 week long phlebotomy course, were split in to 2 groups and trained using one of the two styles. Both groups were given the same amount of didactic training except for the 2 practice methods shown in Fig.2 and Fig.3.

Fig 2. NASCO mannequin training arm.

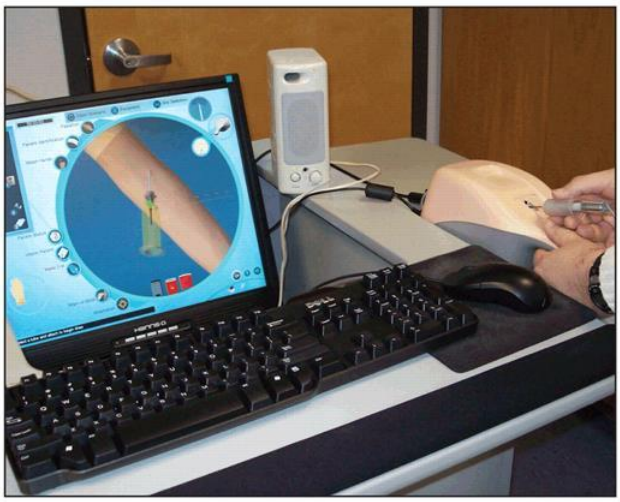

Fig 3. The Virtual Phlebotomy System

The results of the study showed both methods demonstrated a significant improvement over baseline assessments with the mannequin arm, but showed slightly greater improvement. As this was more of a simulated experience compared to a serious game that this paper is researching for, it gave useful information towards the advantages of virtual reality and controller based training against the traditional methods.

Although game based learning for such serious games is becoming a new forum of education through healthcare and medical training, causing scientific research on the effectiveness to be very limited. With the ideal training instruments, with certain parameters or game-metrics to access the trainee's performance. If training and testing of medical students is to be carried out in digital game-based environments, strict requirements should be met. The use of these games and underlying game-metrics must be reliable, relevant, valid and cause specific. With the use of scientific research and testing, before a serious game can be implemented in to the medical training curriculum.

3. Method

From the previous research into serious games and there use towards the medical field, primarily phlebotomy, the art of taking blood, we can see there has not been many forth pushing serious games but instead virtual reality simulators. The use of creating a serious game instead of simulator would push the learning aspects and the participants focus towards getting a higher score, or further training. In the creation of our serious game we will focus on the medical student who are studying in the field or nursing, phlebotomy, and doctoral degrees.

3.1. Serious Game Concept

Our concept for the serious game was to create a game in where the student will be able to learn the steps of taking blood, from the gathering of equipment, to preparation, insertion of the needle, to the completion and care of the patient. This would not just teach the student how to take the blood, but how to completely care for the patient from entering the room to leaving. The following will be a range of the key areas and descriptors that will be essential towards a full serious game experience:

3.1.1. Setting

The game will be set in a medical room, a very clean and well light area. The room will consist of a medical chair/bed where the patient would be seated, a tray consisting of all the medical supplies that are needed to complete the procedure, this research image is shown in Fig.4.

Fig 4. Phlebotomy Room

3.1.2. Game Play

The serious game will play very similar towards the game as Surgeon Simulator, where the player will be able to control the hands of the medical staff member. Picking up objects off tables on the side and using them to complete the specific medical procedure. In Surgeon Simulator Fig 5, the player can complete a wide range of medical tasks, using specific keys on the keyboard that move one finger at a time, with the task of completing it before the patient runs out off blood. Not really a feature we are wanting in our game as it gives of the wrong impression to what the serious game is focusing on, with trying to teach how to take blood.

Fig 5. Surgeon Simulator Gameplay

Our serious game will start with an introduction, where the player will need to follow the steps from washing their hands, confirming patient details, checking for any allergies, explain the procedure, and check understanding and gain consent. The player will have a multi choice questions of what is the correct line to say, such as:

"I need to take a blood sample which will involve?

A - "inserting a needle into your vein."
B - "inserting a needle into your arm."

"It will feel like a sharp _____ and shouldn't take long"

A – "Scratch"
B – "Nick"
C – "Nip"

After this initial introduction the player will then go to gathering equipment, the player will then have to collect the correct equipment from a list which will be shown, this will include the following: Clean protective tray, non-sterile gloves, tourniquet, blood sample device (butterfly needle and barrel), blood specimen bottles, sharps container, alcohol swab, gauze or cotton wool ball, sterile plaster, laboratory forms (labels and transport bad). This is shown is Figure 6.

Fig 6. Gathered Equipment

Once the player has collected the correct equipment, they will continue towards the preparation phase. This will consist with the insurance that the patient is lying or sitting comfortably. The player will then continue to the more main function of the game, with the placing of the tourniquet about 4-5 fingers width above the planned venepuncture site. They will then need to find the vein, by choosing a vein that has a sizeable lumen and feels "springy" and then tap on the vein gently to make it easier to visualize and feel.

The player will then move onto the insertion of the needle following these main steps*:

1 - Attach the needle to the barrel *(some blood collection systems come pre-assembled, such as the butterfly needle with barrel shown in the video)*
2 - Unsheathe the needle
3 - Anchor the vein from below with your non-dominant hand by gently pulling on the skin distal to the insertion site
4 - Warn the patient of a sharp scratch
5 - Insert the needle through the skin at a 30-degree angle or less, with the bevel facing upwards
6 - Advance the needle a further 1-2 mm into the vein after flashback is seen
7 - Lower and anchor the needle to the patient's skin
8 - Fill the blood sample bottles by attaching each in turn to the collection system
9 - Release the tourniquet
10 - Withdraw the needle and then apply gentle pressure to the site with some gauze or cotton wool
11 - Ask the patient to hold the gauze or cotton wool in place whilst you dispose of the needle into a sharps container
12 - Apply a dressing to the patient's arm (*cotton wool / gauze / plaster*)
13 - Discard the used equipment into the appropriate waste bin

*Steps took from Dr Lewis Potter's guide on how to take blood. (Potter, 2107).

Once the player has completed the procedure, the user will be shown their score, with what areas they may have not done the best in. It will consist of their time, the percentage of how much they filled the vile up with blood, and their marks to the multi choice quiz. The game will save the scores of each player and compare them together to be able to create an accurate graph of players ability to score. This will give us the ability to conclude the use of serious games in the medical field, primarily focusing as the ability to take blood.

3.2. Serious Game Actuality

The following is the prototype serious game that we created, taking as many as possible of the features from our researched concept in the previous section, for the learning act of taking blood by a medical student. We had chosen to create our game using the Unity engine, this decision had come about due to our knowledge and use of the engine. Unity was the best engine for us to use for this serious game as it has a very wide range of assets, including objects, sound, art, and more to be able to create a good-looking game, along with a fully functional one as well. Unity allow for the use of keyboard and mouse or our option of a controller, this will give the player force feedback for when they hit the correct vein, fill the vile up to the right amount, and more. The Unity game engine is the most advanced engine used for immersive experiences, in Bourke's paper on the use of the Unity game engine and immersion in an iDome, explains that unity is mainly used for games, it runs with single display and it generates a single perspective projection, the use of the unity engine in the iDome would give an even greater immersive experience (Bourke, 2009). The immersion of the Unity engine is ever advancing with each year of recent technology, in an article by Takahashi, the development of immersion hopes to bring high-quality feedback to more games. He states that game developers can now use Unity to access immersions Touch Sense Force Haptic Lab to integrate touch effects into their game built with unity (Takahashi, 2017). With the help of this technology, the use of a serious game in the process of taking blood and could grow further than just mouse and keyboard, or controller. This technology along with virtual reality devices could show use full towards the full medical field, in the case of training and surgical procedures.

3.2.1. Setting

As in the serious game concept, the game is set in a medical room, surrounded by the appropriate equipment and atmosphere, this room will be where the full procedure is completed. The room has a prominent char with patient already sitting, to where the user will then approach them to start the game. Figure 7, shows what the room setting was like in the prototype version used for testing.

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Fig 7. Medical Room Setting

3.2.2. Game Play

The first prototype development stage of the serious game was to create the working mechanism for which the game will primarily be based around. This mechanism is the working arm that will be use to take blood from, this arm will be a static object which will portray the veins to where the user is to take blood from, shown in figure 8. This will count towards the main scoring feature of the game, the user will hover over the arm using the mouse to where they will be able to click to draw blood, and this will appear as a loading counter to where the user will have to stop as they get to 100%. This will contribute along with the time that is recorded in the back ground to give them a percentage score out of 100, this will then be later used in Section 5 for results.

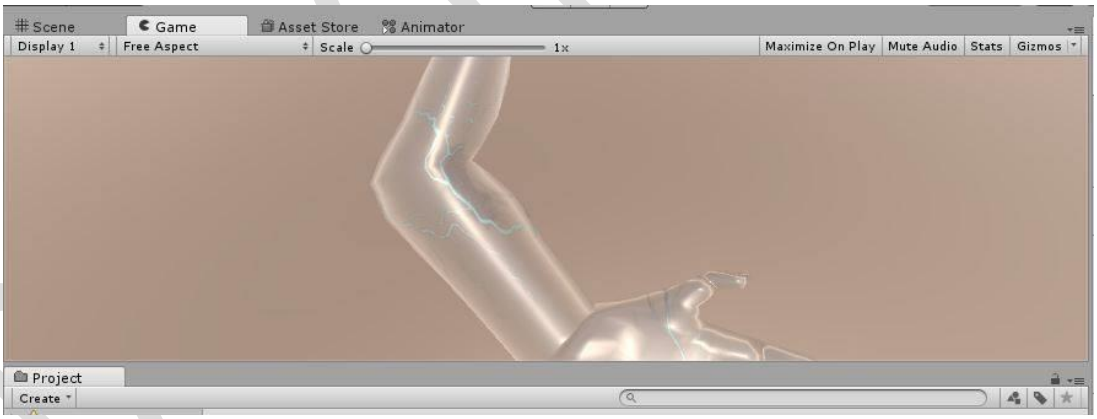

Fig 8. Game Play of Arm

This prototyped arm was the one used in the testing as it allowed for a larger research group at the time of when they were available, and where the prototype game was at the development stage.

The second development phase towards the game play was to make the simulated experience more towards a game. This was completed by adding a score board to show the users percentage of the sample table filled up and their time taken to complete the procedure. As stated in the concept for the serious game, the mention of a mini game feature of a small quizzes, which would pop up throughout the game to add some more learning feature to serious game. This was not able to be completed due to time

constraints with the way the Unity engine conducts these small game features. The advantages towards adding a small quiz feature would allow for further game play scoring mechanics, this would break down full scoring mechanic to smaller areas to show the user where they would have to focus further learning on.

4. Testing

4.1. Testing Research

The testing phase is the most crucial part towards the development of a serious game, especially towards the use in medical education, this phase can make or break the further development, and look towards implementation in to medical education. When looking at the most effective way to test a serious game, a key area of usability. There are many methods that can be used to assess the usability, as described by Macleod, these methods can broadly be catalogued as 1) expert methods, which expert evaluators identify potential drawbacks and usability issues; 2) theoretical methods, which theoretical model tools and user behaviours are compared to predicted usability issues, and 3) user methods, where software prototypes are given to end users to interact with (Macleod et al., 1993). With the use of user methods, another two key steps exist, observational and analysis, this is where a user would interact with the serious game while the developers observe, and survey based methods, with where the user would fill in an evaluation questionnaire after playing the serious game.

These questionnaires will also be used to apply to expert methods, and they are typically based on the rules that can help potential problems. Although, some of these metrics suffer from a common weakness, that they can produce different results when reapplied to the serious game as stated in Wechsung and Naumann paper on evaluation methods and comparison standardization of usability questionnaires (Wechsung and Naumann, 2008). This shows that it is common for such questionnaires and methods to focus on producing usability scores within the serious game, rather than having the identification of the specific usability issues. However, to be able to measure the usability of a serious game, the acceptance towards education resources, game design, UI development, and rigorous usability testing are increasingly necessary. As stated in Loh's book on designing online game assessment, the usability of serious games has gained less attention in literature and that designing serious games are increasingly accessed by broad audiences that include non-gamers, that can result in occasional unpleasant experience. The design of a serious game to accommodate the broader audience to ensure that a usability analytics are performed and can improve these unpleasant experiences.

The gathering of data to evaluate the usability of this serious game is somewhat open-ended towards the difference of possible approaches with potential drawbacks. Consequently, the need of straight forward methods to help the development and identify usability issues for the serious game before testing and future possibilities. As in Moreno's paper on the testing of usability for serious game, they state the following key requirements that to identify to perform usability testing. These being 1) Test Users; by having a set of users to evaluate the prototype, 2) Prototype Session Evaluators; where evaluators analyse the play session of each test user, 3) Instrument for Serious Game Usability Evaluation; for evaluators to identify uses, with the use of a structured method for annotating events with appropriate categories, 4) Data Recording Setup; more suitable for nonverbal, fast paced, and unpredictable user play throughs, 5) A "Ready-to-Play" Prototype; should be as close to final product as possible for users to evaluate, and, 6) Goal-Oriented Play-Session Script; this prior to user test, a play session script was determined, this script states the objectives that are to be completed (Moreno et al., 2012).

Another researched possible area of testing looked upon Neuroevolution of Augmenting Topologies, most commonly known as NEAT is a generic algorithm for the generation of evolving artificial neural networks. Stanley and Miikkulainen's paper on the evolving neural networks through Augmenting Topologies looks at the importance of Neuroevolution and how to gain advantages from evolving neural networks along with weights. This is completed by taking NEAT through a challenged benchmark on reinforced learning tasks, and testing through a series of ambition studies that demonstrate the component to the system (Stanley and Miikkulainen, 2002). The NEAT with the use of an emulator or game play device would run each game with the goal of completion, it completes this by simulating the gameplay many more times than a player could play. In an example in Super Mario World, this system is set up to use Neuroevolution to complete a level. The Mario character uses a neural network (NN) to simulate a human brain, it started out not knowing even to move right, and simulated the different combination of buttons. The NN will read if the player is on a white block and press the right block and if a black box comes into screen to avoid it, the further the character is on the level the fitness level goes up, and only the highest fitness level will bread on to the next evolution to get further in the level to completion. This forum of NEAT works well with side scroller games, but as further research into this topic, it was found that the use of this in a first-person game would not be easily accessed and more work would be needed to complete this phase. Although not very vital research towards this serious game, the research was completed to show another way of testing with the view of getting large amount of plays towards a game whilst it runs its self.

4.2. Testing Stage

This information into the testing of usability, a key area to focus on, allows for the initial testing methodology to be produced. In the testing phase this paper arranged for medical students from two classes (54, with a 25 to 29 split) at the same level at the University of the West of Scotland to be participants in testing. This test started with one of the classes (C1) having an unspecified 10 item survey addresses demographics, game play experience and attitudes towards phlebotomy training using game play mechanics before they tester the prototype serious game, instructions on how to take blood, this short instruction period was to see if prior knowledge would help. The other class (C2) going straight into the testing of the prototype serious game. The advantages towards C1 having a small survey before play testing, put them into the correct mind frame for what they were to be testing, this was shown in the results which is stated in further sections with other statistics. Where on the other hand, C2 did not know what was being tested when they went straight to the game play testing.

The survey for participants in C1 looked at their back-ground. This had such questions to their knowledge of phlebotomy, if they had any medical training in this area, and questions on a general nature, such as gender, medical training level, any use of serious game, and video game knowledge. Once completed the participants of C1 and C2 were then asked the same to go and play test the serious game, here they were given instructions on what the objectives where and the controls they needed.

In the play test section, the game was monitored by moderators, who helped if any of the participants were stuck and could not figure out the next solution, they were also monitored in the background of the game by tracking their time and score. The game testing scored each participant out of 100, this included the small surveys in the game, the amount of blood that was filled up in the sample tubes, and their time to complete. The background data collected all this data and compiled it towards a percentage out of 100 for each participant.

Once the participants had completed the play test, they were guided to a questionnaire (on google forms), this forum dependant on the class (C1 or C2) had a different questionnaire. The questionnaire for C1 bypassed the initial questions of primary knowledge of phlebotomy and medical training, and focused more upon the game play. Where C2 questionnaire asked the participant to fill out the full form, this included their knowledge of phlebotomy, if they had any medical training in this area, and questions on a general nature, such as gender, medical training level, any use of serious game, and video game knowledge. The following figure 9 is an excerpt of the google forum that both classes had the same questions.

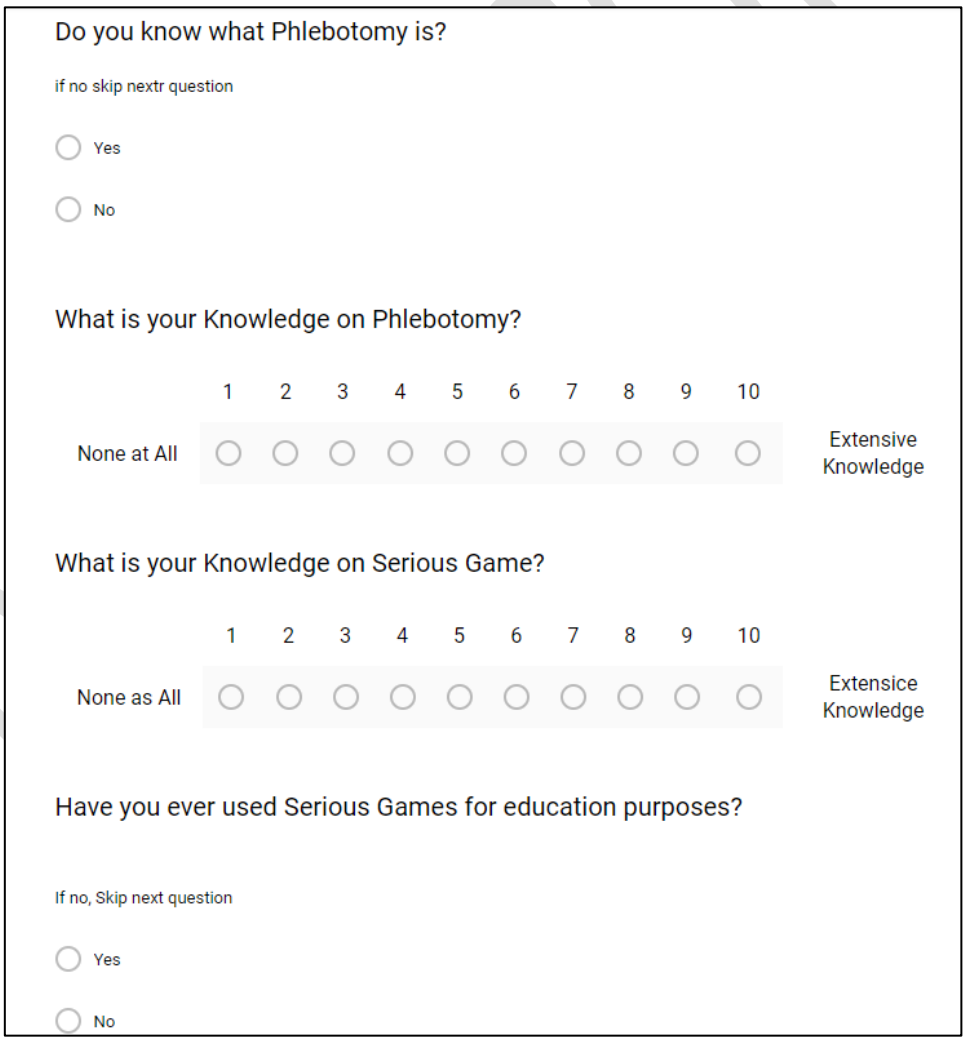

Fig 9. Questionnaire

The questionnaire also asked about the game they had just played, this focused on the effectiveness of teaching / showing what was required to do, to complete the objectives that had been stated before they started. This also questioned more detail into the game, with if they found the game effective to learning phlebotomy, did they think that phlebotomy learning would be better as a serious game. There were also more questions towards the game, such as, was the game good looking, was the game immersive to your learning experience, and would they use serious games towards learning in the future.

All the data from these questionnaires and data from the game play was entered into an analytics system to create graphs and charts to show if there was significant data, which will be detailed in the result section.

5. Results

Overall, 54 participating medical students (C1 with 25 and C2 with 29) completed the full testing phase from questionnaires to gameplay, concluding in the following results. The first class C1 participants were given a primary survey to detail any information that they knew and information on how to take blood to help those that did not know any information a quick over view. The second class C2 were lead straight into the game, with no prior knowledge towards the game they will be testing and would rely on any knowledge that they know or just follow the instructions in the game. The game tested their ability to follow the instructions and gave them a score out of 100, this included the small surveys in the game, the amount of blood that was filled up in the sample tubes, and their time to complete. This include the background data collected and compiled it towards a percentage out of 100 for each participant. Figure 10, shows the percentage that each player got on their first paly though of the serious game.

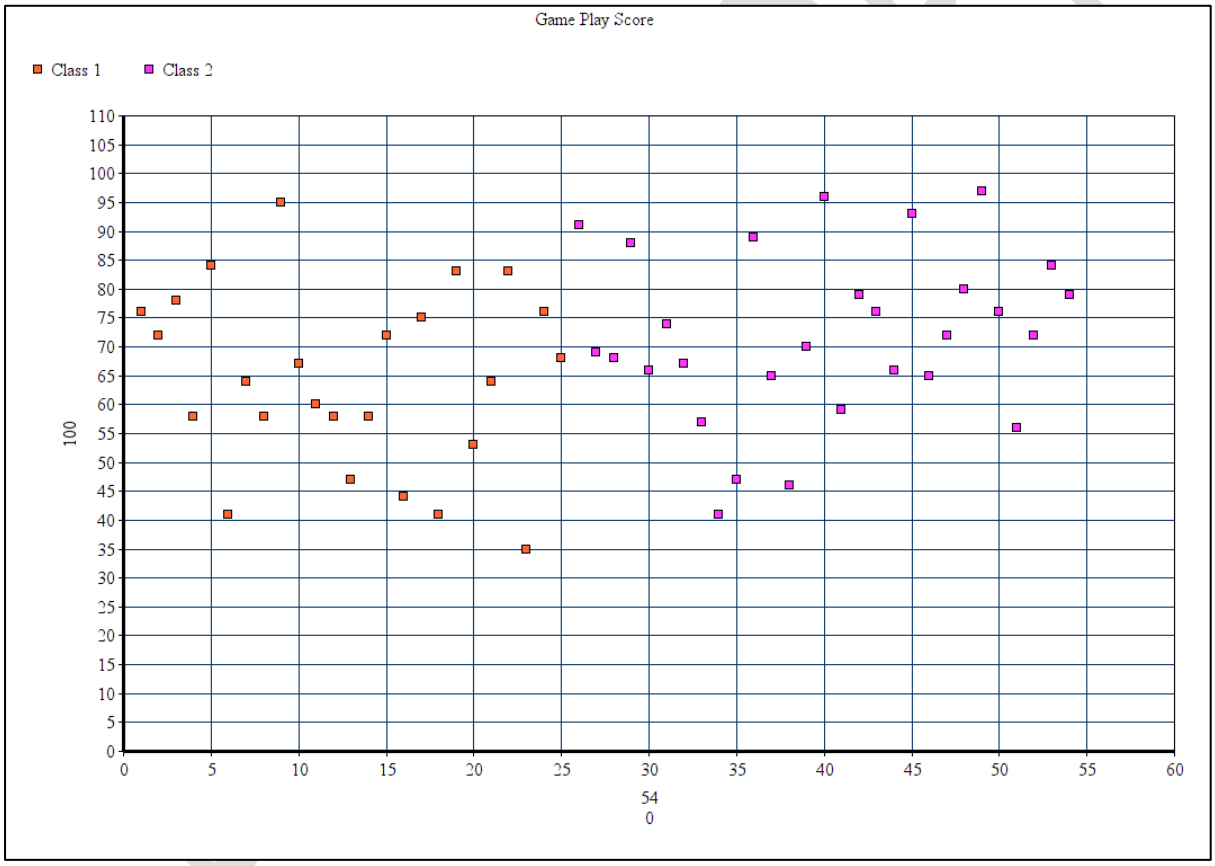

Fig 10, Game Play Percentage Graph

This graph shows the percentage each player got out of 100 on their first paly through of the game, with C1 in the orange and C2 in the pink. C1 participant received instructional help before hand and C2 went straight into the game. In the above table, it is shown that the most common score is about the 65-70% mark. With C2 having an over all larger group with 29 participants the average percentage score was 68% and C1 having 25 participants gave an average of 56%. These results do not show highly towards the benefits to previous knowledge before going into the testing phase, this could also be down to any number of reasons other

than previous knowledge. In the previous research, Scerbo's paper on the medical virtual reality simulator for training phlebotomy, the results of that research had very similar percentage marks, although a more thorough in the research by setting it over the space of two weeks. The results of this paper came out to 63% for the virtual reality simulated arm and 49.1% for the simulated arm (Scerbo, Schmidt and Bliss, 2006).

With the use of the questionnaire and looking at the results for C1 and C2 compared together, shows that C1 who received prior instructions to the game play section, that their answers were lower than C2 that did not receive any prior instructions. The results for C1 show that not many knew in detail what phlebotomy is, and that only a couple had used a serious game in the past. Whereas, C2 had more than 50% of the participants knowing what phlebotomy was prior to the game play, and more than the C1, had used serious games for learning in the past.

6. Conclusion

Phlebotomy is the medical process of making an incision in to a vein with a needle to obtain blood samples or veils. Here we described the initial development of a serious game to introduce and train medical students to be able to perform the tasks in a fun and engaging manner. With the use of todays technology, the serious game can be prototyped to allow for quick development and research data. The data was obtained through the investigation of testing the prototyped serious game and use of questionnaire answered after play testing, shows some support towards the development of serious games along with comparisons to similar studies for the use in phlebotomy and medical training.

This paper hypothesised that with the research data and own testing data shows that learning phlebotomy in a first-person gaming environment, that the participants would have an improved understanding of the process rather than traditional methods, allow much more research and testing would be needed to gain interest into the medical training studies. And that those who are pre-trained with the use of a serious game could perform better technically due to their better understanding of the cognitive process and ability to focus on the technical aspect of learning.

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This is the critical appraisal of the team and the work completed. This was written with inputs from all the team members.

Critical Appraisal

The first stage of this module was to start on the literature review, this was completed by myself Calum along with the full documentation. Most of the literature was completed by week 5-6 where the rest of the documentation was started on the serious game. The testing phase was also completed by myself Calum, by sorting the testing groups and creating the questionnaires.

The Game prototype was completed by Cameron and Chloe, to which had a prototype working by the time I (Calum) had the testing groups. They then worked on bettering the second prototype phase for the demo and submission by adding in other key features that were needed. The second phase was completed just before submission, and did not get used in the testing phase.

Overall the group and myself felt that, I (Calum) did a major amount of the work with the others focusing only of the game, the game in their words should have been better by the demo and submission phase but would need a lot more work to be eligible for a second phase of research testing.