Do the Benefits of Educational Games and Virtual Patient Finally Outweigh the Drawbacks?

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Abstract

Educational Games (EG) and Virtual Patients (VP) have been used for many years in medical education. In the early stages some may argue their use was driven more by novelty, than their benefits to education. Many papers have been written on the pros and cons of EGs and VPs. The common conclusion states that the drawbacks outweigh the benefits however as the year's roll-on the list of positives continue to increase while the negatives decrease. This paper sets to find out what stage the list of positives and negatives are at this time. Do the positives fully out weigh the negatives or is more time needed to further diminish the list of negatives and strengthen the positives. We look at examples of VPs as well as build an example VP(JDoc) and educational game (SiteSafety) to confidently further prove the benefits of EGs and VPs outweigh the drawbacks.

I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism, I.6.1 [SIMULATION AND MODELING]: Simulation Theory, I.6.4 [SIMULATION AND MODELING]: Model Validation and Analysis, I.6.7 [SIMULATION AND MODELING]: Simulation Support Systems

1. Introduction

The concept of "Computer Based Training" can be traced back to the 1960's. Its' positives and negatives were clear to see. The key principles were to give immediate feedback, to decompose the learning process into a sequence of small steps (which augments the probability of positive rein-forcement, and to individualize the learning activities (amount of time, number of difficulty of exercises). These principles were transferred from paper-based programme instruction to the first computer-based teaching programs in the sixties [C64]. The benefits, although minimal, were clear to see but the basic negatives of cost and user ability kept computer based training confined to a minimum. It wasn't until the first release of the Mosaic web browser in 1993 that the most off-putting factor of Computer Based Training (CBT), user ability, began to be tackled. The general public still had the fear of using computers but those that were interested could now see a future in CBT. The Dot-com bubble, having promised a lot and delivered little, including numerous failed e-learning projects gave further evidence that CBL had a place in education. In 2001 Greenhalgh claims that that the use of online tools and systems had become an essential part of the medical education environment. He puts this down to diminishing technical barriers. Although diminished they were still causing problems for many medical schools.

"Many medical schools are discovering the prohibitive cost of producing high quality computer assisted learning materials. The cost of hardware and software, and telephone line charges, often prove a more important barrier to accessing web-based materials than the course organisers initially assume. The amount of training needed to become comfortable with specialised software packages is often underestimated; students on a course that relies heavily on computer work may spend most of their first term getting to grips with the technology" [G01].

He also states that failure of students to engage with newly introduced technology is a recurring theme in reports on non-medical education. Perceived barriers include inadequate planning, poor integration with other forms of learning, and cultural resistance from staff. One ethnographic study in which students were closely observed while taking part in online courses showed that considerable frustration and time wasting arose from poor course design, technical glitches, "dead" hypertext links, poorly coordinated real time seminars, and ambiguous instruction. From Greenhalgh's work it is clear to see that in 2001 there was still much work needed in the area of CBT. The list of negatives for CBT is now clear to see. Leaders in the field

creating VPs and EGs may have been doing so for the novelty factor but every year technology was advancing, getting cheaper and the benefits of CBT were getting stronger. Since 2001 diminishing technical and cost barriers and ongoing changes in educational practices as a whole have brought VPs and EGs closer to forming a part of the medical education mainstream.

2. The need for VPs and EGs in Medical Education and Assessment.

VPs are computer-based simulations of patient management, incorporating narrative and media, designed to teach and/or examine candidate skills in patient management [RCP09]. Educational games and web-based clinical cases VPs provide the potential for valid, cost-effective teaching and assessment of clinical skills, especially clinical reasoning skills, of medical students [GBY*09]. It is only recently that the virtual patient has begun to enter the mainstream of medical education. If a student does not encounter patients with a particular clinical condition the student should be able to remedy the gap by a simulated experience' [EPV09].

Choules notes that VPs generally go beyond what might be referred to as simply 'multimedia-enhanced patients' – such as video of a consultation that models good practice in history-taking – to applications that allow students to consider a full clinical scenario, often in narrative format and with degrees of difficulty that can be adjusted to suit learners' skill level. Such VPs are characteristically media-dense ('high-fidelity'), often incorporating video/animation and artificial intelligence features that allow for interaction with the 'patient', scope for physical examination and investigation of test results – a fitting application of technology for problem-based, authentic learning [C01].

There are numerous arguments for including virtual patients in the medical curriculum. As rates of chronic disease in the developed world continue to rise and outpatient care and shorter hospital admissions become the norm, exemplar cases are less readily available to medical trainees; VPs augment clinical observation and enhance the breadth and consistency of the educational experience. In addition, students report that they appreciate the 'safe' context and structured feedback that virtual patients provide [BCM01].Almost all comparisons of media-rich VPs show that they are well-received as pedagogic tools, and at least as effective as standard teaching [IH07]. Advances in clinical care are reducing patient time spent in hospitals. [P*01] This means that the availability of patients for engagement in teaching activities is diminishing even as the numbers of students are growing, with a 38.1% increase between 2002 and 2007 in the UK (Higher Education Statistics Agency 2009).Virtual patients employing a range of technologies and software to replicate common or important patient presentations provide students with a reliable, safe and repeatable environment in which to rehearse and practise diagnostic skills and develop clinical reasoning [RCP09].

2.1. VPs and EGs as Assessment Tools

Assessment, when used correctly, can be one of the most important steps in student learning. There are several testing modes, written papers with different question formats, computer aided assessment, oral exams, and practical exams with real or simulated patients (SPs). Every department has its existing assessment format and routine, which had been implemented for good reasons in the past, but which need to be reconsidered when new opportunities or concepts are available. The use of computers as the medium for summative assessment grows in importance. It offers new opportunities to integrate multimedia elements like videos and interactive graphics, and especially the idea of automatic marking makes it very attractive for teachers when large student populations need to be assessed [C04].

Assessments should accurately predict future performance in a wide variety of settings yet be feasible to conduct. In medical education a robust and comprehensive system of assessment is essential to protect the public from poor professional standards. The parameters for devising such an assessment are well-defined and good practice for writing examinations is well-established [RCP09]. Medical assessment must try to decide if a student will perform adequately as a doctor. They need to prove their ability to collect information, integrate and reference it against previous acquired knowledge and decide on a management plan. Completing VPs and EGs that have been designed to a high standard can become this proof.

3. The Pros and the "Presumed" Cons

3.1. The Benefits of VPs and EGs

EGs and VPs have been used for many years in medical education. It was the strength of the core benefits and the knowledge that time and technological advancements would overcome many of the off-putting issues. Below is a list of VPs and EGs core benefits in Medical education and Assessment:

1. The ability to make mistakes without real world repercussions
2. Exposure to wider range of incidents and patient scenarios
3. The ability to investigate alternative courses of action
4. Learning at a time, place and pace convenient to the learner
5. Formative or summative assessment with consistent feedback
6. Sound, images and video (test a candidate's skill in integrating multiple pieces of information)
7. Multi-step
8. Reliable
9. Mistakes are often correctable

10. Economies of scale (Once an application has been set up, the incremental cost of offering it to additional students is relatively small)

11. More realistic context than paper-based assessments

3.1.1. The ability to make mistakes without real world repercussions

In aviation, simulation is used in order to train pilots to cope with the most extreme, dangerous and critical situations, in which the costs of mistakes may be high because they pose direct threats to human life [GSF04]. Applying a similar approach to medical practice make sense because it too, involves threats to human life and strives to prevent or minimize such incidents. Realistically simulating the anxiety, confusion and lack of confidence that are characteristic of extreme and hard-to-handle cases is an important means to improve the ability to cope with similar instances in real life. Thus, the intensity and difficulty of the simulated experience may be critical in turning it into a powerful and efficient learning experience. In comparison to common learning methods CAL, especially Virtual Patients and Educational Games, give the learner the facility to make mistakes without real world repercussions. Other methods of learning, such as simulated patients (SPs) also facilitate this. SPs may have a higher fidelity and overall standard of realism superior than VPs and EGs but they have many negatives that VPs and EGs do not have. These include economies of scale, ability to learn at a time, place and pace convenient to the learner. High-quality results come from a combination of the above learning facilities.

3.1.2. The ability to investigate alternative courses of action

One shortcoming of paper-based assessments is its confinement to the linear form. Each question is predefined. User's actions and answers to previous questions, do not affect future scenarios. The examination can only proceed in a single direction. This generates a static test and basic learning environment. On the contrary VPs and EPs are dynamic. Each action causes reactions further down the assessment line. This form of assessment also gives, if relevant, the user's the ability to return and correct mistakes. This multi-step form of assessment teaches the user the importance of all their actions as well as making them understand the consequences of their decisions and the opportunity of returning to fix a mistake could exist [PCK*09].

Collecting of countless VP scenarios from many diverse hospitals is achievable. This would give users access to a wide range of incidents at all times.

3.1.3. Formative or summative assessment with consistent feedback

VPs and EGs can also be tailored to suit different types of assessment. Generally they are used as a formative or summative tool. They can also, and for some more importantly, be used as a diagnostic tool for students themselves. They can be setup to return feedback after the user has completed a single step, a block of steps or the full teaching/learning scenario. This feedback can be anything from, listing elements to review and work upon, to showing the user through the correct way of completing the scenario.

Students can become effective problem-solvers only when they have mastered the art of critical thinking and have acquired the discipline necessary to be self-paced learners. Constant assessment and feedback are critical, so that both student and educator can establish whether the student is mastering the essential material.

3.1.4. More realistic context than paper-based assessments

Gesundheit setup Web-based VPs and tested them on 27 medical students. These students rated the VPs as realistic and appropriately challenging. They particularly liked the ability of VPs to show physical abnormalities (such as abnormal heart and lung sounds, skin lesions, and neurological findings), a feature that is absent in standardized patient.[GBY*09].

3.1.5. Overall benefits of VPs and EGs

Ellaway notes that the strength of virtual patients is to promote and/or assess clinical reasoning [CT09] particularly in complex and emergent settings. In other words, virtual patients are uniquely suited safe and controlled environment. Very few facilities are available day, week and year round to be used at the learners' convenience [EPV09]

EGs offer possibilities for objective, integrated, comprehensive and context appropriate testing of patient assessment and management. No other tool can do this, so VPs and EGs may be able to improve the quality of healthcare examination. VPs can be used on or off line and can either produce marks visible or invisible to the candidate. They can be used in formative or summative assessments. Being multi-step, the patient can improve, deteriorate or develop new features. Because each candidate has the same 'patient', a VP should be reliable [RCP09].

3.2. The "presumed" negatives of VPs and EGs

VPs and EGs have limitations and like all learning and assessment tools will always have limitations. The difference being, as most other learning and assessment tools negatives increase, VPs and EGs continue to decrease. Similar to all commodities that rely on technology, advances rely heavily on many independent, yet linked, industries. The technology sector will continue to progress and carry all that is reliant and dependant on it. VPs and EGs are no different. As the reliability, speed and security of average personal computer improves so will all Computer Assisted Learning (CAL) and Computer Based Assessment (CBA) tools. Below is a list of VPs and EGs presumed negatives in Medical education and Assessment:

1. Cost
2. Teacher being comfortable and embrace approach
3. Time consuming to make
4. Security
5. Student unfamiliarity with computers

3.2.1. Cost

Cost has always been the main concern with CAL. In an American survey produced by Huang in 2007 it notes that the average cost of a VP is between US$10–50,000, with some over US$100,000 [HRC07]. These figures show exactly why cost is perceived as the major disincentive behind hospitals investing in VPs. The figure that ought to be looked at is how much would VP creation cost today. Over the past decade the cost of the software needed to create high fidelity VPs and EGs either dropped significantly or an open source version has been produced. The two most obvious examples are the game engine and modelling software. Previously any high-fidelity serious game would have needed to use the Unreal Engine (USD 10,000) and a high end modelling package like 3ds Max (USD 3495.00). Today, an exceptionally high standard can be built for a fraction of the cost using Torque (USD 295.00) or Unity (Indie USD199.00) and blender (Free). The only cost left is labour costs.

3.2.2. Teacher being comfortable and embrace approach

Assessor commitment to the system is vital. There were, and are many obstacles to overcome with assessors, especially those who are very Computer illiterate. In today's society a standard of Information and Communication Technology (ICT) competency is now expected of teachers and assessors. To learn and work successfully in an increasingly complex and knowledge based society, students and teachers must utilise and embrace technology effectively. Being prepared to use technology and knowing how that technology can support student learning has become an integral skill in every teacher's professional repertoire (ICT COMPETENCY STANDARDS FOR TEACHERS.). The majority (89.6%) of teachers have received computer training [MB02]. A teacher being uncomfortable using a pc is no longer acceptable.

3.2.3. Security

VPs and EGs used for assessment must be secured against manipulation from the side of the students. When setup correctly, the internet can be employed to reach an acceptable level of security. It has the ability to securely deliver test material, reliable time control, reliable and secure recognition and evaluation of user actions, tamper-resistant evaluation of tests, secure creation and delivery of feedback. Compare this to paper based assessment where you have the usual human errors.

One of the major security issues with Simulated Patient Assessment is evaluation repetition. Once a student is tested on a simulation they can pass on information to other students waiting to be tested. In CBA additional security is provided by randomising the order of questions delivered to different students, hence the chances of copying from adjacent candidates attempting the same questions are minimised. There is also potential for the creation of a large question bank that could even deliver a different test to each candidate, reducing security issues further [C04].

3.2.4. Student unfamiliarity with computers

Most of the statistics from the Irish Central Statistics Office (ICSO) in 2006 indicated that the population of Ireland is continuing to accept PCs and the internet at a steady pace, although individuals who have traditionally been reluctant to take to the "Information Society" remain outside the loop. For example, the CSO said that computer usage is highest for students and persons in employment and is lowest for those aged 65 or over. 56% (828,356/1,462,296) of households in Ireland, 99.7% of primary school [MB02], 100% of secondary schools and 100% of colleges have computer access. Initial concerns were that lack of familiarity with computers would affect performance although several studies, comparing modes of delivering a test, showed this did not occur Without doubt, the digital age is upon us, with undergraduate students from a wide range of disciplines accustomed to, and proficient in, using digital software for recreational and social use [p09].

This year Gormley setup a self-administered questionnaire to capture undergraduate medical students perceived level of IT ability and accessibility as well as experiences and attitudes towards e-learning and clinical skills training. The majority of students reported good access to computers and the internet, both on and off campus and appear confident using IT. Overall students felt that e-learning had a positive impact on their learning of clinical skills and was comparable to other traditional forms of clinical skills teaching. Students who displayed deep learning traits when using e-learning, performed better in clinical skills [GCB09].

3.3. Continuing changes

With computer and internet speeds always getting faster and cheaper, software always improving, teachers and students becoming more proficient and embracing the digital age, tomorrow will always be more advantageous than today. So how can we claim that we are at the optimum time for educational games and virtual patient creation? We have now reached the period where the influences of all the negatives towards VPs and EGs creation have been reduced close to a minimum. Ellaway claims that a gradual lessening of barriers to adoption and wider changes in the educational environment have led to virtual patients becoming increasingly practical and desirable as an educational modality [EPV09].

4. Examples:

To further understand the authentic cost of setting up a VP or EG we created two case examples. The first (JDoc) was

built keeping the expenditure to an absolute minimum and the second (SiteSafety) was kept to a tight budget with only the addition expense of man-hours.

The purpose for building JDoc was to demonstrate the possibilities of VPs as method of training that could help alleviate the gap in training introduced by the European Working Time Directive [SMP08]. The introduction of the European Working Time Directive (EWTD) has placed serious constraints upon medical education and has proven to be a major challenge for conventional training methods. Finding time for training has become an issue. The concern medical staff are facing is that on-site training fits into the EWTD's classification of work, and is therefore included in the allotted hours. Incorporating VPs that can be used both, in medical faculties and on home computers can alleviate this problem. JDoc was built in corporation with Cork University Hospital (CUH). It was tested and evaluated on Junior Doctors at CUH [SPM08]. SiteSafety has only recently been built and in the process of evaluation.

Tools	JDoc	SiteSafety	Cost
Game Engine	*Torque Game Engine*	*Torque Game Engine*	*$150*
3D Modelling Tool	*Blender*	*Blender*	*Free*
Integrated Development Environment (IDE)	*Visual Studio 2005 Express*	*Visual Studio 2005 Express*	*Free*
Photo Editor	*Gimp*	*Gimp*	*Free*
People	*Two students*	*Three part-time*	*NA*
Text editor	*textEdit*	*textEdit*	*Free*

Table 1: JDoc Vs SiteSafety Comparison and Cost Table

When comparing JDoc with SiteSafety it is clear to see the overall cost excluding man-hours is equivalent ($150). The only difference between the two is JDoc was built by two students and SiteSafety was built by two graphic designers and a student. Both JDoc and SiteSafety have been validated demonstrating 100% of users "feel JDoc is a beneficial Education and Assessment tool".

Figure 1: *SiteSafety*

Figure 2: *JDoc.*

When comparing the two products it is apparent that SiteSafety, as a result of higher standard of graphics, is of a superior visual quality.

In both examples the benefits of VPs and EGs over paper based training and assessment are employed and utilised.

1. The ability to make mistakes without real world repercussions, multi-step, ability to investigate alternative courses of action, mistakes are often correctable

Although making a mistake could cost a user a grade, there is no threat to human life. If possible the user may return to his mistake and fix it or investigate an alternative course of action.

2. Learning at a time, place and pace convenient to the learner, exposure to wider range of incidents and patient scenarios, formative or summative assessment with consistent feedback

Unlike Simulated Patients, JDoc is available to use at anytime and at any pace. The user can retry the scenario as many times as they wish. With a database of scenarios the user can gain exposure to a wide range of incidents. The

scenarios can also be setup to return formative or summative feedback to the user.

3. Sound, images and video, more realistic context than paper-based assessments

Training videos, supportive images, background, foreground and immersive sound are embedded in both JDoc and SiteSafety. This tests a candidate's skill in integrating multiple pieces of information and also adds realism to the scenario

4. Economies of scale

Once JDoc and SiteSafety are setup there is no cost per student. Students that want to use the software can use the software.

JDoc and SiteSafety have demonstrated the benefits of EGs and VPs while keeping cost, the main obstacle, to a minimum

4.1. Other Examples

The Centre for Medical and Healthcare Education at St George's University of London's (SGUL) medical school have developed a generic framework for VP creation. The principal idea behind their framework is "easy creation" for educators with the flexibility to simulate real decisions through non-linear pathways. Feedback was very positive with many educators being able to create their own VPs after training and a workshop.

5. Conclusion

There is a growing need to develop assessment methods for clinical reasoning and decision-making. One such method includes the use of VPs for assessment. It has been shown that VPs and EGs are beneficial to education [PCK*09] and assessment [WGZ08] but are we at the optimum time for educational games and virtual patient creation? Many points critical of VP and EG creation are now non existent or at least the benefits of VP and EG now strongly outweigh them. Cost has always been the most significant negative. By building and validating JDoc and SiteSafety we have provided an example where the cost of creating VPs and EGs can be kept to a minimum. Considering all of the above we feel the benefits of Educational Games and Virtual Patient do outweigh the drawbacks.

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