The Effect on Learning using Gesture Controlled Technology in Education: A positive improvement or unwelcome distraction?

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Abstract:

There have been massive leaps in gesture controlled technology in recent years with the release of games peripherals that enable players to interact with their consoles in innovative new ways by just moving parts of their body. While the technology has been popularised with great success in video games, it currently has limited exposure and usage in an education environment.

This new way of interacting with digital systems has lead to new thinking on educational applications and their place in the modern, technology enabled classroom.

The main purpose of this paper is to find out what the effect of using Gesture Controlled technology has on learning for the student. Other points of interest also include the effects on the teacher and the modern educational environment in general.

The questions asked are can this technology can fill the gap where other technology has failed to integrate itself into teaching environments before? And if it can, what is the best way to implement it?

The emerging gesture controlled applications that are coming to fruition are researched for their effects on learning and the various learning processes; active, cognitive and creative learning that gesture controlled interaction enables. Though study of learning methods, this paper aims to find out how using gesture controlled applications affect a students learning, the student's requirements of such technology, the implications of this for the teacher and the educational environment in general. With particular focus on the effects of learning to the student, the effect on the teacher is also analysed.

The conclusion is intended to summarise a number of factors, including the positives and negatives of gesture controlled learning applications for learning, the effects on the student, teacher and classroom. The intended outcome is to clarify the validity use of such technology, its optimum place and usage in an educational environment and the potential to improve not only the learning experience of the individual student but the class group and possibly the teacher as well.

Introduction

Technology has managed to find its way into almost every factor of the modern life, everything is connected, and people carry around smart phones, laptops and order coffee through a computer system. Post has given way to emails. CDs have been lost to download. Information is constantly and instantly available at any time in any place. ‘Google’ has even become a verb in the Oxford English Dictionary.

However in the classroom, things seem to be largely unaffected by the latest technologies. Yes, there are computers everywhere but if the projector is broken the lesson falls to pieces, the teacher relying on the age old medium of PowerPoint to attempt to engage students. How can students in the current day be engaged by a PowerPoint presentation when they could easily make a better one themselves?

This dissertation argues the case that certain technologies can have a massive positive impact in education. It focuses on the range of Gesture Controlled technology available today, in particular Gesture Controller User Interfaces (GCUI) and the student’s interaction with it, rather than an in-depth look at the hardware. The ways in which these exciting technologies are currently used in education are researched, along with their effect on learning. The topic of integration of these technologies into a classroom environment is also looked at and how it can help improve learning in terms of creativity and engagement.

This paper researches various types of learning, focusing on Gesture Based and active learning, the effectiveness of each and how it applies to the technology currently available. Existing educational applications using Gesture Control are studied in terms of engagement and creativity, highlighting why they are effective and also the negative aspects.

The questions raised throughout this dissertation are can this technology have a positive effect on learning? Is it being embraced and if not, why? Is it feasible for educational systems to incorporate these technologies or are they just fads? The outcome of this research expects to find if learning processes can be greatly improved or prove an unwelcome distraction.

Chapter 1: History of Gesture Controlled Interfaces

The modern world is full of gesture controlled interfaces and you would be excused in believing that this technology is a recent development thanks to the popularization of these ideas in entertainment devices such as Apples iPhone and Microsoft's Kinect, but actually that is not the case. The idea for gesture based interaction in technology has actually been around for decades but it is only now that it is becoming accurate enough to become a joyful experience and therefore gain wider exposure.

This chapter looks at the definition of the term Gesture Recognition, the history of gesture controlled technology, its pioneers and early research.

What is Gesture Recognition Technology?

Gesture recognition is a technology which enables humans to interact with computer systems without the need for a traditional input device such as a mouse or keyboard. Movements of the person are recorded through visual or kinaesthetic sensor devices and are then calculated to be understood by computers through complex mathematical algorithms.

The lack of any mechanical device means that computer applications that were previously too complex to interact with (especially for older generations) could possibly be used by all age levels and skills. In the case of Sony's EyeToy video game released in 1999, the player would stand in front of the device and with no other input apart from body gestures; they would be projected onto the screen and could interact with objects in the game through movement of their body. It is widely believed (Preece, Rogers, Sharp, 2011, p.198) that this type of interaction meant the game could be played by people of all age groups and without computer experience.

Since then, the use of gesture controlled technology has moved away from simply novel use in video games to being all around us, especially for people in education.

Commercialized and made accessible primarily by Apples iPhone and iPad, Nintendo's Wii and Microsoft's Kinect for the Xbox 360, most age groups partaking in education today will be exposed at some point to operating these devices in the form of gestures - including tapping, swiping, squeezing and all sorts of physical movements that allow a control of a system without the need for buttons.

In the modern day it is nothing unusual for people to own a whole range of devices that function through the use of gestures; smart phones are used by almost all age groups from children to older generations and for a range of purposes including business, education or purely for entertainment.

Early projects using gesture control: "Put-That-There"

Back in 1980, computing was very different from the way we know it today. Most Software applications did not have graphical user interface so interaction was limited to a rather bland looking command line input. Richard A. Bolt (1980), a Physics professor at the Massachusetts Institute of Technology (MIT), realised the potential of using gesture controlled technology to create comfortable and natural interaction with a computer;

> 'Recent technological advances in connected speech recognition and position sensing in space have encouraged the notion that voice and gesture inputs at the graphics interface can converge to provide a concerted, natural user modality.' (Bolt, 1980, p.262)

Bolt developed a prototype application called 'Put-That-There'. The project experimented with voice-input and gesture-recognition to operate a software application.

The aim of the project was to enable a person to control a series of simple shapes on a large screen through only voice and gesture. Bolt declared that gesture combined with voice recognition was a powerful and accurate method of interaction;

> 'Because voice can be augmented with simultaneous pointing, the free usage of pronouns becomes possible, with a corresponding gain in naturalness and economy of expression. Conversely, gesture aided by voice gains precision in its power to reference.' (Bolt, 1980, p.262)

The technologies used to create this system were quite complex and varied due to the technology available at the time. The system had a limited number of recognised words and only up to five words were allowed to be spoken in each sentence.

The user was seated in a chair in the centre of a room, situated in front of a large screen. The participant wore a head-mounted microphone and the sensor cube was attached to the wrist, although Bolt (1980, p.265) also points out that due to its size, it would be easy to wear as a ring, mounted on a cap or installed in a cuff of a jacket as well.

The system had a limited range of simple voice commands, which included an action, a colour and a shape, for example;

‘Create a blue square there.’

Bolt’s system recognized these 4 parameters (Create, blue, square, there) as part of a single command. The user has a gesture controlled cursor which was displayed on the screen through the action of pointing. When stating the command “There”, the current X and Y co-ordinate of the cursor was used to position the newly generated shape.

This was a groundbreaking project because Bolt presented the concept of continuous visual feedback and designed the system based on what is most convenient for the user. Bolt argued that the use of such a system is easy for the user to use and saw the potential for gesture based control technology in a more practical application;

> ‘More real-life examples of commanding about "things" in a more meaningful space come readily to mind: moving ships about a harbour map in planning a harbour facility; moving battalion formations about as overlays on a terrain map; facilities planning, where rooms and hallways as rectangles are tried out "here" and "there.’

Importantly, Bolt implies here that the system was just an indication of the possibilities using gesture and voice control. He states that this type of interaction is ‘spontaneous’ and ‘natural’;

> ‘The power of the described technique is that indications of what is to be done with these visible, out-there-on-view items can be expressed spontaneously and naturally in ways which are compatible with the spirit and nature of the display: one is pointing to them, addressing them in spoken words, not typed symbols.’ (Bolt, 1980, p.270)

The technology here, whilst primitive by today’s standards, showed what could be achieved and that its effect on interaction could be spontaneous, versatile and natural.

Vincent John Vincent and Francis MacDougall

Another influential figure in the development of gesture controlled technology is Vincent John Vincent. Vincent is an innovator, entrepreneur, inventor and pioneer and is the founder of the world leader in gesture control technology, GestureTek. Vincent was first a performer and has dedicated his entire career to producing pioneering gesture based technologies and pushing the boundaries.

It all started in the early 1980's while Vincent was at the University of Waterloo studying for a degree in Psychology. Keenan (2011) explains that it was through Vincent's hobby of dancing that he foresaw the possibilities of interaction and potential for creativity through use of gesture controlled technology. Vincent thought that if a dancer's movement could be tracked via technology whilst they were dancing, it could be used to create and add to the music itself. The music could be made to follow the dancer and not the other way around.

Since Vincent did not have a technically skilled background, he partnered with a computer student, friend and fellow dancer Francis MacDougall, who was integral for programming Vincent's ideas and turning them into reality. After not too long, the pair realised that they were very limited by the technology of the time, with even the most advanced computers processing data at a snail's pace compared to the speed they would need to develop a real time responsive gesture recognition application.

It was not until 1985 that technology finally caught up to enable Vincent and MacDougall to turn their long developed idea into reality. That technology was made available in the form of the Commodore Amiga, as it had a real-time digitizer, fast graphics chips and powerful processing capabilities (Keenan, 2011).

In comparisons to Bolts 'Put that there' system, Vincent claims they realised early on that a complex arrangement of sensors would not be good enough and instead decided they would use a video camera to record a live feed of the user. The colour data would be used to transform them into a virtual world.

The first prototype of their gesture controlled system was created in 1986 and showed a real-time feed from a video camera to display a person standing in front of a grid. The computer would make sounds depending on what square of the grid the person moved their hand to. They then added animation to the interface so people could manipulate real images. Initially the company focused on building a musical interface for Vincent to use during public demonstrations of the technology and by 1986 the first version was created.

It was the first truly real time engaging gesture controlled virtual environment and with it Vincent became the world's first virtual reality performer.

Speaking at the 2011 TED (technology, entertainment and design) conference in Waterloo, Vincent believed to be truly engaged and not thinking about anything other than the task at hand, you had to 'step into the virtual world unencumbered, because that's how we are in the real world' (TEDxTalks, 2011).

The technology naturally found a place within the video games industry to create immersive video games, but Vincent also found that the system generated a lot of interest from people involved fitness and rehabilitation;

> 'This idea that we had, this tool, would actually be a positive use of technology to enhance whole body development. It was borne out by the way worlds of fitness and rehabilitation responded to this technology. Through the mid to late 1990's, we worked with endless physio and rehabilitation therapists, we studied the technology and wrote papers. Essentially on its positive aspects, in terms of recovering from injuries etc.' (TEDxTalks, 2011)

This ended up with the creation of IREX (Interactive Rehabilitation Exercise), a system designed to allow therapists to create exercises and record progress through interactive gestures of patients.

However, therapists weren't the only ones getting excited by the technology. Keenan (2011) describes how Vincent thought the idea could be used to potentially control a computer for any purpose;

> 'Very quickly, they realized that a technology that would allow body gestures to control sounds could allow body gestures to control computers in any number of ways.'

Of most relevance for this paper is was the potential of its use in educational institutions for its motivational factors. Vincent explains;

> 'The educators knew from the world of brain science and from the dedications of the neural plasticity of the brain that there's a hierarchy of the learning and retention process. The more sense you engage, the more interaction you have, the more you are going to learn and retain.' (TEDxTalks, 2011)

There was a clear application for this technology in education and its positive possibilities in terms of engagement and information retention were recognised by educators early on. The main issue standing in the way of its use in education is how it could be implemented into the classroom.

GestureTek Inc

In 1986 Vincent along with Francis MacDougall founded the company GestureTek Inc, which develops and licenses gesture recognition software.

GestureTek is an incredibly important company in the field of gesture control technology as it holds many patents (http://www.gesturetek.com/, no date) used in numerous devices including Microsoft's popular Kinect sensor.

As well as video games, GestureTek's technology is already used in education, marketing and healthcare. GestureTek claim that using gesture controlled applications in education can create an engaging learning experience;

> 'Gesture control interactive technology in schools creates a dynamic and engaging learning environment, engaging students and taking the learning experience to new heights. Floors, tables, walls, even desktops, can become an interactive display medium to teach the curriculum, entertain students during playtime, and even reinforce specific physical and cognitive skills.' (http://www.gesturetek.com/marketuses/education.php, no date)

Chapter 2: Gesture Control in Education

The nature of gestures is universal. It is widely supported that children learn communication through gestures before speech (Bhuiyan and Picking, 2009). The use of gestural interaction in computers is much more natural that operating a mouse and keyboard because it is closer to real life and how we interact with our physical world. It is for these reasons that there is a plausible argument that it would be a valuable tool for teaching, in that it greatly enhances the potential and efficiency of learning in terms of being able to retain information and increase attention spans through immersion.

Since the introduction of Apple's gesture based iPhone and more recently, the release of the Microsoft Kinect, more natural gesture based user interfaces are increasingly being developed for use in education. According to the 2011 Horizon Report, whilst the usage of gesture-based applications for the purposes of learning is still formative in education, it should be seriously considered due to the information being so readily available around them in their everyday lives .

> 'While the full realization of the potential of gesture-based computing remains several years away, especially in education, its significance cannot be underestimated, especially for a new generation of students accustomed to touching, tapping, swiping, jumping, and moving as a means of engaging with information.' (Johnson *et al*, 2011)

Early opinions of Technology in Education

As early as 1969, the introduction of computers in various avenues of everyday life (such as computerised payroll systems and assistive use of computers in scientific experiments) sparked much debate and thought into the application of various technologies in education.

Patrick Colonel Suppes is an American philosopher who has made significant contributions to many things but most relevant to this paper is his research into educational technology. He is currently the Lucie Stern Professor of Philosophy Emeritus at the Stanford University School of Education and has written a multitude of papers relating to technology in education.

There was clear potential for use of computers in education and Suppes foresaw that it could revolutionise the way we learn way back in 1969;

> ‘As yet, the use of computer technology in administration and management on the one hand, and scientific and engineering applications on the other, far exceed direct applications in education. However, if potentials are properly realized, the character and nature of education during the course of our lifetimes will be radically changed.’ (Suppes, 1969, pp.41-47)

While not specifically focused on gesture based computing, it is worth pointing out because it was considered there was massive potential for general computer technologies in education. With the devices and technology available, it was apparent that they could be applied in educational practices but there were major issues that would have to be addressed. Due to education practices being so widespread and varied, it meant implementation of computer technology would be expensive and there was also a problem of how to actually work the systems, as Suppes states;

> ‘So, with such devices available, individualized instruction in a wide variety of subject matters may be offered to students of all ages. The technologies already available, although it will continue to be improved. There are two main factors standing in our way. One is that currently it is expensive to prepare an individualized curriculum. The second factor, and even more important, is that as yet we have little operational experience in precisely how this should best be done’ (Suppes, 1969, p.42).

The question seemed to be that how can you apply technologies across such a wide vary of educational practices and how to apply it fairly? What is the best way to take advantage of this potential?

Suppes concludes ‘The real problem is that as yet we do not understand very well how to take advantage of this potential’ (Suppes, 1969, p.42).

This seems to be the question that seems to of prevented mass integration of technology over the years. PowerPoint technology and projector systems have found their place but this is largely to help the purposes of the lecturer. While they may argue it makes their teaching more interactive and interesting, is this still the case when students can delve into their pockets, take our their latest Smartphone and Google the subject matter through a nice user interface and interact with the results with gestures and touch?

Immersive interfaces and the effect on motivation

Any gesture controlled application can be regarded as an immersive system so for that reason this section will look at immersive and virtual reality interaction, with keen focus on the motivational aspects and how this relates to gesture controlled interfaces.

Not until the millennium were immersive interfaces being studied for the effects on learning. One particular study of interest used an immersive gesture controlled system with an accompanying head-mounted tracking device. The goal was to discover the effects on attention spans of teenagers using this immersive technology and if it could be used to enhance it.

Cho's study took 30 teenagers with slight behavioural or social problems and randomly put them into 1 of 3 groups; A Virtual Reality (VR) group, a non-VR group, and a control group. The VR group had a head-mounted display (HMD) and positional sensor, where as the non-VR group did not. The control group used a standard computer and input devices (mouse and keyboard). The groups performed various cognitive training tasks and the results were monitored over a 2 week period.

Cho developed a Virtual Environment for enhancing attention in which his cognitive based training sessions could be carried out. The Virtual Environment took the form of a small classroom which had a whiteboard, a desk, some chairs, a teacher 'avatar', a friend avatar, a large window looking out onto a playground and some pictures in frames on the wall. The student can see themselves in the virtual world sitting at the desk and therefore become fully immersed in this world.

The various tasks were simple cognitive and exercises aimed at recording sustained attention, such as being presented with a constant series of changing numbers. The subject was to respond only when the number 0 is shown after a number, except when the display shows the number 8. As the subject progresses, the length of time the numbers are displayed for increases, meaning that the subject must devote and sustain higher levels of attention to the task.

The study looked at a range of factors including the number of correct answers, errors and reaction time. These factors were then compared between the 3 groups. The results found that VR-enhanced cognitive training was more effective than standard cognitive training or no training at all for teenagers with attention and behaviour difficulties. It proved that using this technology could enhance the attention span;

> ‘These results prove that VE cognitive training, which is an application of exposure therapy, is more effective than existing cognitive training in improving the attention span of children and adolescents with behavioural problems and helping them learn to focus on some tasks. We can also say that immersive VR may be appropriate for attention enhancement’ (Cho *et al*, 2002, p.134).

Cho concludes that the reason virtual reality can hold attention better is because it’s ‘immersive, interactive, imaginable, and interesting’.

Another study (Burdea and Coiffet, 2003) into Virtual Reality environments back up the claim that Virtual reality can also increase motivation because of its individualised learning experience;

> ‘Through its interaction environment, repetition, and one-to-one experimentation, VR can help improve knowledge retention and student motivation’ (Burdea and Coiffet, 2003, p.314).

The research suggests that virtual reality and immersive systems in general are highly motivational and therefore have positive potential as an educational tool.

Existing apps using Gesture Control Technology (Case studies)

Kinect Math

Kinect Math is a really interesting use of gesture control in the classroom. It includes various features including a tracking mode which can track user's displacement over time and calculate velocity and acceleration when walking forwards and back, it then visualises this data in real time on the screen. It also allows the user to manipulate lines or parabolas physically by using their hands and gestures. Users can affect the slope of a line and the origin of a parabola and see the changes displayed on a graph in front of them in real time.

The most interesting aspect of this application is that it gives students an easy way to visualise abstract mathematical concepts and interact with them in real time. One of the main issues in learning Mathematics is being able to accurately predict the outcome of complex sums and algorithms. Some students may respond to a more visual approach to these problems and there is a clear benefit in having such problems presented to them in a visual and interactive way.

Robin Angotii, Professor of Mathematics at The University of Washington in Bothell, United States is one of the first to pioneer Kinetic Math in a real classroom and argues that because there is a diverse range of students it is difficult to effectively teach them all using one single approach;

> 'High school education is facing some tough problems. Classrooms are more diverse than ever. Teachers have a responsibility and obligation to teach the classroom in a fair and equitable way and I've really been bothered in my whole professional career by students who are really bright and intelligent but didn't necessarily think of math in the traditional way we think of as students who are bright at math. What I mean by that is we think of students who are good at math as being very algorithmic, they can do procedures, they can have an equation and solve it. But some kids are really bright at math in a lot of other ways they're really visual they can do the mathematics they just can't necessarily do it in the traditional that way we think of math' (Jackwei0831, 2011).

Kinect Math tackles this issue by combining all sorts of learning methods including Kinaesthetic, collaborative and active learning. Because of this it means that it reaches students on many more levels than traditional paper and diagram based learning methods.

It is more engaging because it is active learning or learning by doing. Robin claims that the novelty of technology also helps students to be more engaged;

> ‘Kids like technology, they like video games, it’s the fact I’m not standing up there in front of the classroom just talking at them for an hour, they’re actually moving and getting up and doing things’ (Jackwei0831, 2011).

In addition, the interaction with the system is very visible and therefore promotes aspects of collaborative learning. The interaction with the system happens with a real person making physical gestures in real time in front of a group in a classroom environment. This means it is possible to incorporate collaborative learning as part of the interaction process, engaging students to help each other suggest solutions and discover the effects through doing. Robin describes that even if one student is using the system, the rest of the class is also giving feedback to help achieve the task.

It is this combination of different learning methodologies that make this technology so interesting. Robin also raises the point that in using Microsoft’s Kinect, it is a fairly cost effective method of introducing effective technology into the classroom;

> ‘Dynamic technologies in Mathematics has shown significant impact to student learning, and that’s the real beauty of it is now I’ve got a relatively inexpensive sensor that could hook to the teachers regular classroom computer, they don’t need any special board mounted on the wall that’s going to cost thousands of dollars, that will allow them to have all their kids be able to interact with mathematics in this tremendous way’ (Jackwei0831, 2011).

Kinect Orchestra

Ray Chambers is an ICT teacher at Lodge Park Technology College in Northamptonshire, England. He has been writing education applications for the Kinect since 2011 and practising his applications first hand on his students. Chambers work is particularly interesting because they are some of the first apps for the Kinect written directly for focused learning of a particular aspect within a subject.

Of particular interest is his Kinect application, the Kinect Orchestra. The Kinect Orchestra has been tested in a real educational environment in collaboration with Gareth Ritter (2011) a secondary school music teacher based at Willows High School in Cardiff. Ritter has used Chambers work first hand with his students and in particular The Kinect Orchestra to teach students about where instruments are positioned in an orchestral environment.

The Kinect Orchestra is an application controlled purely by gestures. A large screen displays a simple diagram of a traditional orchestra layout where all the positions are left blank. Along the bottom of the screen there are various instruments that the user can interact with, selecting, moving and dropping through a variety of hand and arm gestures. The student is required to place each instrument in the position he/she thinks is correct and the system provides visual and audio feedback depending on if the placement of the instrument is correct.

This use of gesture control highlights the effectiveness of the application in education, the students enjoy this sort of interaction and there is a collaboration element as students can help each other by stating where they think the instrument should go. The physical movement of the instrument turns the learning into a game and the fail/repeat learning style they develop through video games is firmly mirrored.

Ritter states that the effort and learning processes children unknowingly apply to video games can potentially have the same effects in learning;

> ‘I am a firm believer that if children are enjoying what they are doing they won’t want to mess about. Technology plays a huge part in that theory. At home children are playing on their Xbox 360′s or PlayStation 3′s and when they fail a level the first thing they do is have another go and they don’t give up. By bringing some of this technology into the classroom, hopefully their effort and want to succeed will follow’(Ritter, 2011).

Chapter 3: Learning methods

The following chapter looks at the various learning methods that are or could be utilised through gesture controlled technology and their potential for educational purposes.

As the comparison of learning methods is difficult to analyse when looking at specific technologies (such as gesture controlled applications), the use of digital technology in general is used here instead to investigate its impact on teachers, students and the relationship between them. The status of the teacher and student is looked at and the learning processes possible with technology is reviewed to determine if there is a clear application for successful and impactful integration of gesture controlled technology in an educational environment to benefit the student and also the teacher.

Cognitive Learning

This chapter will describe what cognition is, look at the cognitive aspects in learning and how this relates to, and effects the creation and usage of gesture based learning environments.

What is cognition?

Cognition in simple terms is the range of processes our brains go through when performing any kind of task. Examples of every day cognition are thinking, remembering, decision making, seeing, writing, reading and talking. We do these things every day and there is a particular science to the level of power our brains devote to each task depending on our level of expertise in them.

For example, when learning to drive a car, the brain devotes as much concentration as possible be able to perform a complex combination of remembering what their instructors told them, making decisions on the road, seeing what’s happening around them, thinking what they should do next. It can be rather exhausting. However, once we have become very efficient at driving our cars, we devote less concentration to it which enables us to focus more on other things.

Norman (1993) states that there are two types of cognition; Reflective and Experiential. The previous example of becoming an accomplished motorist falls into the latter term, experiential, where once the person reaches a certain level of skill and experience; they can get into a car and travel from A to B effortlessly. They do so without actively having to remember what their instructor once told them or remember what gear they should be in, it all comes naturally and all the complex combination of tasks involved in driving are performed without actually realising it.

Cognitive aspects when using technology in learning

The processes of Cognition are important when thinking of new interfaces for learning. Gesture controlled interfaces for the purposes of learning can be powerful for the reason that gestures are instinctively natural in the way humans communicate every day.

As Bhuiyan and Picking (2009) highlight, an important factor to realise is that gestures are instinctively embedded as a means of communication from birth;

> ‘Humans naturally use gesture to communicate. It has been demonstrated that young children can readily learn to communicate with gesture before they learn to talk’ (Bhuiyan and Picking, 2009)

Whilst gestures are so commonly used in everyday communication, this aspect of communication is lost almost entirely when interacting with computer based technologies as we know it today.

When using a traditional computer, your only method of communication is to use a keyboard and a mouse to instruct it what you want to achieve. Whilst it could be argued that it is fairly intuitive because it has been around for so long, it still needs initial instruction on how to use and some age groups find it almost impossible to interact with comfortably. As an example, to achieve something as basic as drawing a stickman on a computer, even with the most popular of graphic manipulation software it can take hours of instruction due to the complex process of navigating through the various tools you need to select. Compared to the process of drawing a stickman in a traditional way, it can be done with just a pen, paper and few simple gestures in a matter of seconds.

The method of achieving a task or learning to do something is greatly affected by the tools we use to do it. Norman (1993) argues that without external aids, (Such as a pen and paper) the human ability to perform cognitive tasks is more difficult and it is the tools we create that help improve our learning processes and abilities;

> 'The real powers come from devising external aids that enhance cognitive abilities. How have we increased memory, thought, and reasoning? By the invention of external aids: It is things that make us smart. Some assistance comes through cooperative social behaviour; some arises through exploitation of the information present in the environment; and some comes through the development of tools of thought – cognitive artifacts – that complement abilities and strengthen mental powers' (Norman, 1993).

It seems it would be reasonable to argue that the effectiveness of how well we learn is very much complemented by the tools which surround us. In a previous example we looked at Kinect Math (Chapter 2), a gesture based application in which users could plot and manipulate mathematical angles through gestures – could it be argued that this is a much more effective tool for learning about the effect of angles than traditional tools such as using angle rulers and reading books? By using an innovative gesture based system does it initiative a more active learning approach, increase attention levels, engagement and improve results?

Kinaesthetic learning

A study into Kinaesthetic learning (learning by doing a physical movement) by Susan Goldin-Meadow, Susan Wagner Cook, and Zachary A. Mitchell for the University of Chicago looked at how gesturing can help children learn how to solve basic mathematic problems.

In the study, the students were given the equation 3+2+8=__+8 to solve and were divided into three groups. One group was taught to say what they wanted to achieve, which was "Make one side equal to the other side". The second group was taught to say the same words, but this time along with a gesture of pointing at the numbers and where they wished them to go. The third group was taught again to say the words and a gesture, but the gesture would be focusing on the wrong numbers they needed to focus on to achieve the correct answer.

All three groups were then given the same lesson, in which they were instructed to repeat the words/gestures for each problem presented which they had been taught prior to the lesson. After the lesson the students were then tested and were instructed to explain how they managed to solve the problem.

The study showed that the students who repeated the correct gesture during the lesson solved more problems correctly than the students taught to gesture at the incorrect numbers, and an even greater improvement was shown compared to the students who were not encouraged to gesture at all.

> ‘We found that children told to move their hands in a fully correct rendition of a particular problem-solving strategy (grouping) during a math lesson solved more math problems correctly after the lesson than children told to move their hands in a partially correct rendition of the strategy, who, in turn, solved more problems correctly than children told not to move their hands at all. This effect was mediated by whether children added the grouping strategy to their post-lesson spoken repertoires, thus suggesting a mechanism by which gesture may influence learning’ (Goldin-Meadow et al, 2009).

Active learning

Active learning is a term used to describe a focus on the learner to actively pursue their own goals, in other words, learning by doing.

A proposed list of effects by Charles C. Bonwell (1991, p.2), one of the pioneers of encouraging the implementation of active learning in classrooms, claims that active learning (as opposed to passive learning) has many positive effects, including making students more engaged, improving their skills, increasing motivation and generally thinking in different ways;

‘Some of the major characteristics associated with active learning strategies include:

1. Students are involved in more than passive listening
2. Students are engaged in activities (e.g., reading, discussing, writing)
3. There is less emphasis placed on information transmission and greater emphasis placed on developing student skills
4. There is greater emphasis placed on the exploration of attitudes and values
5. Student motivation is increased (especially for adult learners)
6. Students can receive immediate feedback from their instructor
7. Students are involved in higher order thinking (analysis, synthesis, evaluation)’

Bonwell takes the standard teaching environment of a lecture and looks at various differences in the level of information remembered, problem solving ability and motivation for further learning by students undertaking standard lectures and active learning methods. Through a combination of research Bonwell boldly concludes that for a student to truly learn, they need to do the task for themselves, and not just think they can achieve the task; ‘All genuine learning is active, not passive. It is a process of discovery in which the student is the main agent, not the teacher’ (Bonwell 1991, p.3).

The question is whether gesture controlled technology or for that matter, technology in general, can overcome this passive learning problem? To really engage the student, an active, studio based environment is required. Introducing gesture controlled technology into the lecture theatre has the potential to increase learning, attention and engagement, but it has to be applied in the correct way.

> ‘The fact that information is carried by light waves instead of sound waves does not automatically make it more effective for learning. Almost everything depends on whether it causes the student to be more active or more passive, and reflects the serial nature of human attention’ (Goodman, 2009, p.68).

Goodman argues that the lecture is now outdated as a medium of teaching. The lecture used to be essential in the early days of University when there was no easy access to printed materials, because students needed to listen and take notes by means of having a reference (See the previous section on cognition) for their study. However in today’s culture of ubiquitous information through our computers and smart phones, students have become accustomed to having the information available instantly just by typing a term into an internet search engine. The need to make concise notes is now replaced by jotting down general terms for further research later, if at all.

> ‘In each case, teachers must ask what thought processes the lecture is arousing in the listeners and how it arouses them. The question must be raised as vigorously with the new technology as with the old. If computer screens simply provide us with a stream of information, verbal or pictorial, students can receive it just as passively as they can listen to lectures. The new technology will improve education only to the extent that it induces continuous mental activity in the student by presenting tasks that require thoughtful responses’ (Goodman, 2009, p.69).

Although this research is not directly focused on Gesture controlled technology, it does apply and include all types of technology in an educational environment in general. It is important to recognise the importance of the application of Gesture controlled applications and not just use it to relay information. It needs to be fully active to be effective for the students learning.

Constructivist learning theory

The constructivist theory is the idea that the student establishes their own projects in order to learn and take responsibility for their learning. In order for the student to self-direct their learning they need to be highly motivated and see an achievable outcome.

Schneiderman states that to make a student motivated, interested and feel like they have accomplished something, the educational process must be fun and the outcome must be visible. A clear goal needs to be seen, played with and accomplished in an interesting way. Schneiderman argues that for an educational experience to motivate and become memorable, it must be joyful and transformational;

> ‘Memorable educational experiences are joyful and transformational. They enrich students with increased knowledge and skills, provide them with a satisfying sense of accomplishment, and reshape their expectations. In these compelling situations, students are driven by intense motivation that propels them to solve challenging problems and fills them with the thrill of accomplishment. They are proud of what they have done, have a clearer sense of who they are, and are ready to take greater responsibility for their education’ (Schneiderman, 2003, p.112).

Active learning follows similar opinions as the constructivist theory, where it is argued that learners are likely to become intellectually engaged when they are ‘working on personally meaningful activities and projects’ (Kafai & Resnick, 1996, p.2).

The attributes of active learning are fully present in gesture controlled technologies, such as the Kinect Math and Kinect Orchestra (As studied in chapter 2). A problem is presented visually, and requires that the students interact to transform it into the desired result. The student can see their effects on the problem which in turn enables them to solve it more effectively.

The Kinect Orchestra showed us that this gesture based learning approach can effectively work in a collaborative way with a small group of people. For this reason there could be an argument that it would not be effective in a larger lecture environment.

Chapter 4: The learning environment and roles of the student and teacher

This section looks at an active studio/workshop environment and its effects on learning, and also how the roles of the student and teacher may change with the introduction of this technology.

Using the example of an apprenticeship undertaken by the famous painter Leonardo Da Vinci in his early years, Da Vinci learned his art whilst working on real world projects in the studio of mentor Andrea Del Verrocchio. (Schneiderman, 2003). During this time under the teaching of Verrocchio, young Leonardo started to produce pieces of art that showed much more skill and were generally far better than Verrocchio's. Verrocchio was apparently so angry with this that he stopped using colours in his work. Being able to focus on his own individual goals and his motivation to succeed his teacher can duly be applied to this active learning environment. Schneiderman states that this type of learning environment motivates and allows students to fully transform their ideas into accomplishments;

> 'Verrocchio should get ample credit for having created an environment that engaged and transformed his students. They worked on individual projects and collaborations with each other or with Verrocchio himself. The art studio model has many advantages, but adapting it to the large number of students in modern schools is difficult. The standard lecture approach scales easily and some lectures are memorable, but studio-like challenges from teachers and interactions among students in small groups are usually more influential' (Schneiderman, 2003, p112).

Interestingly, Schneiderman also points out that implementing a studio based learning style in today's lecture environment may prove difficult, but small groups are usually more effective.

From the information compiled here, it is reasonable to conclude that careful consideration needs to be taken when designing the correct application to integrate gesture based technologies in education. From the case studies of the Kinect Education applications, we can see that it has already been applied successfully in a workshop environment with small groups, and backs up Schneiderman's claim that it is difficult to integrate into a lecture style environment with a larger group.

The shift from teacher based lecturing to student based learning

As previously mentioned, the modern student has a massive diverse range of information available at the touch of a few buttons on their smart phones. Today's information age means teachers are no longer always seen as correct in what they preach, which creates doubt and unease for both the student and the teacher themselves. Both parties are fully aware that the student has more information available to them than the teacher could ever possibly know. This is not a criticism of the teacher, but a fact that the human brain cannot physically store the amount of information that is available through the internet.

This means that many students no longer see the teacher as the definitive source of knowledge on their given subject and this has created much debate in recent years as technology becomes more and more common in the classroom. The role of the teacher has been seen as generally commonplace and central to education throughout history, but the integration of technology in education has lead to a large amount of debate between academic contributors. Some regard the introduction of technology in the classroom as a great help and method of engagement for exploitation by the teacher, whilst others argue that technology dilutes the stature of the teacher and suggest the teacher should take more of a side role or should become more of an assistant to the student. Some extreme opinions on the matter claim that technology eliminates the need of a teacher altogether.

This section looks at the various arguments and summarises the most effective implementation of gesture controlled technologies in the classroom.

How technology could assist the teacher

The first notion covered here is the case that technology can be an asset for the purposes of increasing cognitive thinking in the student – increasing motivation, interest and engagement. However for this to happen, technology has to sometimes take centre stage, with the teacher encouraging students to discover their own answers. Selwyn highlights that through the use of technology in the classroom it allows the teacher to incorporate different forms of learning and switch between them;

> "It is argued, for example, that digital technologies allow a teacher to switch between individualised, communal and communicative forms of pedagogy. This allows the teacher to move from being an organizer of learning activities to being a shaper of quality

> learning experiences. In this sense, most educational technologists are careful to emphasize the continuation of the role of the teacher at the centre of the digitally enhanced pedagogical process' (Selwyn, 2001, p.119).

In this case, the teacher would remain as the authoritative figure in a students learning experience, with technology assisting the teacher for purposes of explanation.

How technology could surpass the teacher

Another notion of how new digital technologies could affect the teacher is that the teacher will take more of a side role in the learning process, with the technology taking preference for the main transfer of information. The idea that the teacher would take more of a support role and overseer is backed by Professor Papert, a teacher at the MIT Media Lab who throughout his career has been a leading figure in reshaping the educational process to help Children learn more effectively.

In an interview with David Bennahum in 1996, Papert's response to the question of whether future students will even have a teacher at all was that there will indeed be a need for a teacher, but it will be as more of a supportive role:

> 'Yes. Will they have adult professionals to facilitate the learning process? Yes. Will these teachers be people who are in a privileged position as the ones who know and the source of knowledge? I do not think so. Not at all. They will have a very different role. Sensitive well-informed adults who understand deeply about learning processes and social interactions will be able to give advice. They will be able to spot that this kid has a problem, or this kid needs more interesting challenges, or put pressure on them and make suggestions' (Papert, 1996)

Papert backs up the argument that learning will be more centred on the students needs, meaning that in order to keep a classroom engaged the modern teacher must embrace new technologies and encourage their use in a collaborative way to help students learn.

However, as in all debates, there are reasons against this shift of power. Whilst there is research and evidence to concur that learning should become less dependent on teachers and more on the learner themselves, some believe there is an issue of motivation in our current culture that must be addressed. Whilst Goodman agrees to the submission of the teacher as we know it to technology to achieve greater learning, he argues that students may not be willing to take the responsibility of their education into their own hands;

> ‘It is essential to help students leave behind their dependency on teachers. This is particularly difficult in cultures such as ours, where a matriarchal society is evidenced in behaviour patterns. These reflect the previous pattern of teaching-learning: “I pay for the teacher to teach me, and explain things to me... not to learn things by myself’

He also claims that because of our set ways and perceptions of what education should be, students may not quite know how to engage with a technology based learning experience.

> ‘A large number of students have been led by the hand under a traditional scheme in which they are mere spectators, as a result, when they are placed on a stage they do not know how to perform’ (Goodman, 2001, p.197).

How technology could replace the teacher

In a rather extreme view of the impact of technology on the teacher, there is the theory that technology will eliminate the need for a teacher altogether.

From research by Selwyn (2001) into distance learning over online ‘Virtual Schools’, it is concluded that there is a reason to believe that the need of a teacher will need to be reconsidered when applying this kind of technology in education;

> ‘All of these proposals for learner-centred and learner-managed educational provision pose serious challenges to the need for the physical presence of the teacher.’ (Selwyn, 2001, p.119).

Teachers however, are often weary of accepting technological change. According to Goodman (2001), teachers not only hold concerns about technology but also in the way it affects their statue. There is an understandable fear for teachers of being seen as less competent in understanding of the technology, having less influence on a groups learning and lacking job satisfaction in the outcome.

Kozma (2003, p.5) describes how implementation of digital technologies in education are leading to a change in perception of the entire nature of education and the roles associated with it. Kozma states that the relationship between the teacher and student must change to embrace today's easy access to a wider range of information that the teacher could possibly ever have;

> 'Re-Imagining the role of the teacher: that is, changing from the teacher as initiator or instruction for the whole class to the teacher as a guide who helps students find their appropriate instructional path and evaluate their own learning'

The need for the student to take more responsibility in his/her learning is also highlighted;

> 'Re-imagining the role of the student: that is, changing from students as passive individuals to students as active learners working in teams to create new knowledge and solve problems' (Kozma, 2003, p.5).

Conclusion

It certainly seems that gesture controlled technologies, such as the Kinect applications analysed in this paper can have a large positive effect in the processes of learning, especially in younger age groups (see Kinect Math and Kinect Orchestra). In a connected world where distractions come easily the need for more interesting and interactive learning processes is clear.

Gesture controlled learning applications can certainly fill the void when it comes to motivation and engagement for the modern student. The cognitive effects combined with active, collaborative, kinaesthetic learning processes and motivational effects are clear to see.

The use of gesture controlled technology should be used in a particular way. Whilst it could be used to demonstrate in a larger lecture environment, it is also apparent that this technology would be best placed within a workshop environment.

Smaller groups of students enable better collaboration and team work. Problems may arise when trying to use a gesture based system in a larger lecture type environment, but it may still prove effective. For the technology to really assist both the learning and teacher, the roles of both must change. The teacher must be willing to take more of an assistive role, where the student defines how they want to learn. The student must also accept more responsibility for their own learning in this case.

The question still remains of where this technology, or it seems any technology for that matter, can sit within the educational structure. Even though fairly cost effective for home use, widespread introduction of Kinect devices in schools for example would prove costly, and involve restructuring of entire lesson plans.

I believe the best method of implementation of gesture controlled applications is in small doses. Using such an educational system should be used to engage a small group of students as a reward for achieving a certain level of theoretical knowledge. Once that level is achieved, it can be put into practise and refined through the immersive and engaging environment that can be provided by gesture controlled interfaces.

Because of the power and possibilities of gesture based learning, I believe it is possible that this type of learning could be introduced to teach the subjects that students often fail to engage much in, or present complex problems that could be displayed and manipulated visually. This is clear in the study of Kinect Math, where students could alter a curve on the graph and see how the angles change in real time. As the study showed, this type of interaction means there is more equality in the learning of a group of students, where students who respond better to certain learning methods (such as active learning) will not be left behind.

In summary, I believe that Interactive gesture based applications can be a great addition to both the student and the teacher. Introducing such innovative technology into a workshop or classroom environment brings a fun factor to education which can't easily be achieved through anything else. The issue of whether it would be a counterproductive distraction remains to some extent, the solution I propose it to introduce the technology as an addition to a terms lesson plans and avoid structuring the learning around it.

The technology when used in the correct environment can increase motivation, productivity, engagement and understanding of subjects through its innovative interaction. It bridges the gaps between procrastinators or students who are not interested and gives a group of different personalities an equal opportunity to learn and have fun at the same time.

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