How do you develop 3d video games that encourage higher order thinking?

E X P E R I E N C E
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Introduction

When reflecting upon using 3d video game technologies in an educational setting, it became evident that my interest extends out of formational experiences learned whilst teaching. Therefore, by way of introduction to this research topic, I will briefly summarize a key educational theory that has moulded my teaching practice and helped guide me towards my present circumstances...

Whilst attending Christchurch Teachers College I was introduced to the art educational theorist Vincent Lanier. Lanier was a somewhat controversial figure whose discussions centered on art aesthetics in education. In particular, discussions on the divide between “high” art aesthetics and “low art” aesthetics in art education, greatly impacted my approach to delivering content in the classroom. He considered there were eight principles in selecting art curriculum content for teaching in classrooms (Lanier, 1984). Two of these I have taken to heart in my approach to teaching art. The first of Lanier’s (1984) principle is “Content (should) be centered on artifacts well within the cultural milieu of the learner.” (p. 233) and secondly, that teachers should “Structure the content of the art curriculum so that it moves from the familiar to the unfamiliar” (p. 234).

In practical terms, in the first year of my teaching career, I constructed a program for Year 9 at Shirley Boys High School in Christchurch, centered around comic books. The students were highly engaged and worked hard. I moved from the familiar genre of comic book action hero to the works of Roy Liechtenstein and the Pop Art movement. This was nothing startling in itself, as many teachers have taught in a similar manner. But for me, the success of the program confirmed all that Lanier was saying. It just seemed to be eminently sensible. Through the gentle introduction of familiar content rooted in their culture, I was able to expand students horizons into other ways of thinking and looking at art, that they had not previously experienced - while at the same time, teaching specific skills in the art making processes.

This realization that students have difficulty engaging in material that is removed from their cultural experiences, lead me to understand that the cultural terms of reference I use are not necessarily the same as theirs. This fundamental understanding resulted in an active effort on my part to keep in touch with students interests and experiences as viewed through their own eyes.

Moreover I discovered that it is not only artifacts found within the cultural milieu of the learner that need to be embedded in learning experiences, but also the toolsets the learners use... For example, as a young photographer, fresh out of Canterbury University Fine Arts School, I had an introduction into the use of digital image manipulation - becoming familiar with Adobe Photoshop version 2.5 when it was in its infancy compared with the technology of today. However even then it provided huge potential and scope to the design and photography teacher in secondary schools. Consequently even whilst a student teacher, I started working with students digitally. I still remember viewing a photography submission when on teaching practice that scored very highly in the external Bursary examinations. The student took a series of photographic images and simply applied standard photoshop filters to them. He received a high mark that was not deserved, and notably the examiners neither identified or understood the technological practice - if they had, they would have recognised it as being outside the required prescription. It was obvious that the examiners were not familiar with Photoshop, nor had they understood that the images had been produced from a digital source and subsequently manipulated to produce the desired effect. Indeed
technological practice plays a large part in our learners culture. Technology therefore has figured to the forefront of my approach to teaching art—where in design, also reflects industry practice. My current position is at Hagley Community College, having moved there from a position as head of department of art at Cashmere High School. Hagley is unique in that it is a secondary school that also has many adult learners. My initial role was to set up a digital based art course using the software Adobe Photoshop and Macromedia Freehand. These courses were quickly established and became part of the fabric of the art department. Additional classes have been added over the years all with a conscious determination to provide instructional material based on Lanier’s two tenets previously mentioned.

From five years ago, these courses developed to include teaching 3D animation using Alias Maya software. Maya being the pre-eminent 3D package used by the film industry and has won an Oscar for technical innovation. This is a high-end 3D animation package, and students have responded extremely well to the opportunity to use it. The course was being developed at the same time the “Lord of the Rings” trilogies were being shot, and subsequently interest in 3D technologies received a great deal of media exposure—ensuring strong interest from students.

The advent of the National Certificate in Educational Achievement has also allowed more flexibility in teaching approaches. Students started to integrate their Level 3 Art Design folders with their interests in 3D modelling and animation. Successful folders resulted, in turn inspiring more students to develop an interest in 3D. It was not long before students, naturally asked to begin investigating 3D modelling in combination with 3D video games—resulting in a Games Design class run for the first time in 2007.

The game development pipeline (the term “pipeline” refers to the sequence of operations involved in constructing a programme) draws on strong design and art practices. Its inclusion in curriculum content is a natural extension, both in terms of the learners cultural experience and technological practice. Participation in the e-fellowship this year, has enabled research into the use of 3D game engine technology within an educational setting, and can be seen as a natural extension to curriculum development based on the aforementioned two of Lanier’s guiding principles.

Herewith, is a record of my journey, a journey of questions, and some answers, and then more questions...
Framing the research question

It seems a long time ago now, that I sat at the CORE Education offices on the corner of Manchester street and Armagh Street in Christchurch, and discussed along with the other e-fellows the detail of what it was we were to undertake this year.

From day one I knew that I wanted to investigate video game strategies that could be used in educational video games. I feel strongly that I have a responsibility to use research in a practical manner, towards using video games in the education environment within New Zealand. I did not and do not want this research to form ink and paper that stagnates on shelves and in digital depositories. Therefore the research needed to be practical, and useful beyond 2007.

Upon reading research it quickly became clear, that there were significant gaps in knowledge about video games and their use in schools. This is not surprising, as it was only last year that the report was published from the American Federation of Scientists (2006): “Summit on Educational Gaming: Harnessing the power of video games for learning”. Included in the key conclusions were:

“There are differences between games for education and games for entertainment. Developers of an educational game must target the desired learning outcome, and then design a game to achieve that target. Educational games must be built on the science of learning. Educational game designers must also design for third-party users of their applications who support, augment, and monitor player progress.

A robust program of research and experimentation is needed to enhance development of educational games by stimulating transfer of the art and technologies of video games to education and learning systems. Research is needed to develop a sound understanding of which features of games are important for learning and why, and how to best design educational games to deliver positive learning outcomes. R & D is needed to support the development of automated tools to streamline the process of developing educational games, and to reduce development costs.” (p. 5)

It struck me that what seemed to be missing from existing research, was a systematic process for game developers to follow and which would provide a framework for developing educational strategies to encourage critical and reflecting thinking. This was to form the basis for framing the hypothesis of the research question:

“How do you develop 3D video games that encourage higher order thinking?”

What also became apparent at the early CORE meetings was that my project was quite different in nature from all others...

The research question could be broadly divided into two fundamental issues:

1. game development processes and procedures
2. thinking and learning processes.

In order to put this into a formal research methodology I have employed the “Soft Systems Methodology” developed by Peter Checkland (1981) and his associates at Lancaster University. This method of approach uses a seven-step process (as cited in Dick and Swenson, 1994).

1. The researcher is immersed in the problematic situation
The problematic situation and its immediate context are defined

Root definitions of the relevant systems (comprising the essence of the systems are defined)

Conceptual models of the systems, intended as improvements, are developed

The conceptual models are compared to reality

Feasible and desirable changes are identified

Action is taken to improve the situation

This process is iterative design and follows the idea that design should be done in repeated cycles where within each cycle, the design is elaborated, refined, with the resultant testing of each cycle feeding into the design focus of the next.

The first phase then, is looking at the situation around video games in education.
The problematic situation

Background: The Culture of Video Games

I still remember the day that I was introduced to Pong, at our family bach in Waikanae. It was addictive and fun. I couldn’t get enough of it - partly because I had two other older brothers to beat. I was not alone in my preoccupation. Pong was the first introduction for many families all over the world to the new possibilities of electronic games. Then for many, there were Friday nights at the local “Fish ’n Chip” shop playing “Space Invaders”, “Pac-man” and “Asteroids”. Home consoles, handhelds, and computer games have all since developed to the sophisticated level we see today.

Video games have come a long way since Pong was introduced in 1974. Today, video games have a significant impact on popular culture, this can be seen in politics, television, films and music. Major universities all over the world now teach papers on video game studies, in departments as varied as art, computer science and psychology. In New Zealand, studies in video game culture and development can be found in Otago, Canterbury, Waikato and Auckland Universities. A number of polytechnics and private training institutions also run courses in 3D animation and game development. For the New Zealand student interested in gaming, there are now real choices in tertiary learning pathways.

Students of today have grown up in a generation where video games are part of the fabric of society. Video games now spawn movies, and movies spawn video games.

Debate rages as to the positive and negative effects of video games. What is certain, is that there is also a lot of myths that influence the way people think and react to the idea of gaming technology in education.

I found the following statistics from the publication “2007 Sales, demographic and usage data; Essential facts about the computer and video game industry” (American Entertainment Software Association, 2007) to be very interesting. The data was gathered in an annual study conducted by Ipsos-Insight for the ESA and is represented as the most indepth and targeted survey of its kind, sampling over 1,200 nationally representative households. Some of the following conclusions were:

In 2007 in America the average player was aged 33. Twenty-four percent were over the age of 50. Contrary to the popular myth that video games are for males, thirty-eight percent of all players are female. Video games are prevalent in homes - and gaming is a family affair. Sixty-seven percent of American heads of household play computer and video games. Ninety-one percent of parents are present at the time games are purchased or rented. Eighty-six percent of the time children receive their parents’ permission before purchasing or renting a game. Fifty-five of parents believe games are a positive part of their children’s lives. Parents always or sometimes monitoring the games their children play ninety percent of the time.

The types of gaming experiences are also changing. Fifty-three percent of online gamers are male, forty-seven percent are female.

The average adult woman plays games 7.4 hours per week. The average adult man plays 7.6 hours per week.

And what about the idea of pasty looking gamers being anti-social “couch potatoes” who are glued to their monitors?
• Gamers devote more than triple the amount of time spent playing games each week to exercising or playing sports, volunteering in the community, religious activities, creative endeavours, cultural activities, and reading.

• In total, gamers spend 23.4 hours per week on these activities, compared to 6.8 hours per week playing games.

• Seventy-nine percent of game players of all ages report exercising or playing sports an average of 20 hours a month.

• Forty-five percent of gamers volunteer an average 5.4 hours per month.

• Ninety-three percent of game players also report reading books or daily newspapers on a regular basis, while sixty-two percent consistently attend cultural events, such as concerts, museums, or the theatre.

• Fifty percent of gamers are regularly involved in creative activities, such as painting, writing, or playing an instrument. In addition, adult gamers exhibit a high level of interest in current events, with ninety-four percent following news and current events, and seventy-eight percent reporting that they vote in most of the elections for which they are eligible.

Reading the above statistics challenged my thinking, to the point that it became clear to me that discussions around video games and learning need to be based in facts, not myths and supposition. There became a need for me to challenge my own established ideas and preconceptions, be open to new ideas and new ways of teaching, and be prepared to ask hard questions. In other words, a critical and reflective thinker -and model to students what it is we as teachers expect of them.

There is also the need to be aware of the “Emperors new clothes” syndrome, where video games in education are starting to receive a lot of attention around the world. In New Zealand, we need to ensure that the lessons we do apply in New Zealand, work for a New Zealand context. Most importantly we need to make sure we are working with this technology for valid reasons.
Existing research into video games in education

Some well known authors advocate the benefits of digital games based learning in some form or another. These include Marc Prensky, Diana Oblinger, Clark Aldrich and James Paul Gee. I have been particularly interested in the work of Prensky and Gee.

A brief overview of some of their thoughts and ideas will help set the scene for the type of research I am interested in. However, just before I do, I found it useful to read “Report 8: Literature Review in Games and Learning” (FutureLab, 2004) in which the field of games research was put into context. It outlined the four following approaches:

• The behaviourist approach views learning in terms of behavioural change and argues that this takes place when adequate external resources and tasks are provided. Education can provide these resources and tasks

• The cognitive approach views learning as something that takes place inside one’s head and so making connections in one’s head is the site of learning. In this approach, education can develop the capacity and skills for one to learn better.

• The humanist approach is about the development of a person’s potential and involves emotional and attitudinal development. In this approach, education tries to make a person more self-reliant and autonomous.

• The social and situational approach views learning as something that takes place in a group context and is dependent upon the relationship between people and the learning environment. Education in this approach provides the opportunity to participate in communities of practice.

Being aware of the position from which these researchers write provides a useful insight into the various arguments used. Gee (1984) for instance, is unashamedly writing from a cognitive approach.

Marc Prensky

Prensky coined the phrases “digital natives” and “digital immigrants” which are in common use in educational circles. These concepts have stimulated much discussion. Essentially Prensky argues that today’s learners (digital natives) think differently and interact more intuitively with today’s technology than previous generations (digital immigrants). He suggests that digital games can encourage learning in new ways, and that these new ways challenge and confront accepted conventions and practices in schools. The following list from Prensky (2001) compares learning with digital games to conventional school and lecture based learning:

• Twitch speed versus conventional speed
• Parallel processing versus linear processing
• Text illustrating the image rather than vice versa
• Random access versus step by step
• Connectivity: synchronous and asynchronous electronic information and communication versus standalone
• Active versus passive: communicating and participating as well as reading
• Orientation towards problem solving: play versus work
• Immediate reward: payoff versus patience
• Fantasy versus reality
• A positive view of technology, brought about by its presence everywhere, unlike previous generations

As an art teacher, I find one of Prensky’s most interesting concepts to be that of today’s learners growing up in a media savvy world, a consequence of which learners are much more adept at “reading” images than previous generations. This idea of being conversant with “visual literacy” is also picked up on, and extended by James Paul Gee.

James Paul Gee

James Paul Gee comes from a cognitive science background, and is interested in how games may help students learn more effectively. He has published several books and collected papers on digital based games with perhaps his most well known book being: “What video games have to teach us about learning and literacy”. Here he articulates why he believes video games exemplify some of the best learning practice known, and identifies some 36 learning principles that can be found within existing off the shelf video games.

The first five learning principles were key to my thinking about this project (Gee, 2003). They are:

The Active, critical learning principle

All aspects of the learning environment (including the ways in which the semiotic domain is designed and presented) are set up to encourage active and critical, not passive, learning.

The Design Principle

Learning about and coming to appreciate design and design principles is core to the learning experience.

The Semiotic Principle

Learning about and coming to appreciate interrelations within and across multiple sign systems (images, words, actions, symbols, artifacts, etc.) as a complex system is core to the learning experience.

The Semiotic Domains Principle

Learning involves mastering, at some level, semiotic domains, and being able to participate, at some level, in the affinity group or groups connected to them.

Metalevel Thinking about Semiotic Domains Principle

Learning involves active and critical thinking about the relationships of the semiotic domain being learned to other semiotic domains. (p. 49-50)
These principles reinforce Lanier’s tenets of moving students from the familiar to the unfamiliar and the sense of choosing learning material that derives from students cultural experiences, for instance, video games.

Gee contends that video games are a new literacy, and that the modern world is rapidly creating new semiotic domains. To clarify the concept of semiotic domains (semiotic being the study of meaning), Gee (2003) likens the learning experience to playing a game of basketball. Basketball has its own unique set of rules. It also has its own set of skills, and unique terminology e.g. “dribbling”, “ankle breaker” or even an “alley oop”. For the beginner there are several key things that occur whilst learning to play the game. Firstly, the learner experiences the world in new ways. Secondly, he/she identifies or affiliates with a social group, in this case the basketball team. Because the basketball player knows the rules of basketball and has developed ball skills, it is easier for the player to transfer this knowledge to playing another game such as netball (in other words another semiotic domain). There are similarities between the two, and the skills required for basketball can certainly be employed in net-ball. The learner/player finds this transition easier because he or she is moving from the one set of rules that they clearly understand to another set of rules in which they find some common ground. (This echoes, somewhat, Vincent Lanier’s theory of moving from the familiar to the unfamiliar, and struck an echo with my own teaching practice.) Thirdly, the learner/player is able to prepare for future learning and problem solving in this domain, and in others.

Gee also believes that the immersive aspects of video games can provide meaningful learning experiences for students in a way that cannot be matched by traditional teaching models. He argues that digital game players engage in what he calls “critical learning” while playing certain games and states that the type of learning required by digital games is “close to what I believe are the best theories of learning in cognitive science” (p 7).

One of the criticisms of Gee’s theory is that the critical learning skills that occur while playing video games do not necessarily transfer into other contexts (Davenport 2002; Buckingham and Sefton-Green 2003:391). I believe that this may be so whilst playing an off the shelf game - but should not be the case in a well designed video game built specifically for educational use. Transference of critical learning skills should be “factored in” as one of the design goals.

Another of Gee’s Learning Principles is:

The Identity Principle

Learning involves taking on and playing with identities in such a way that the learner has real choices (in developing the virtual identity) and ample opportunity to reflect on the relationship between new identities and old ones. There is a tripartite play of identities as learners relate, and reflect on, their multiple real world identities, a virtual identity, and a projective identity (p. 67).
This took me some time, and many readings to get my head around. However it struck me as being very important and relevant to our youth, and so I persisted. Essentially, what Gee is saying is that as teachers we ask students to take on a variety of roles in different ways. I teach art, so when a student comes into my classroom, I expect them to take on the identity of a “student artist”. They learn aspects of visual language and the processes and procedures that are required to put into practice as an artist. For instance in the science lab, teachers expect students to take on the role of “scientist” and are taught to hypothesise and make deductions (become student scientists). Students therefore take on multiple “identities” throughout their school day. Taking on identities, helps learner make sense of the domain they are working in.

Now, in a first person video game (as well as other types) the player takes on the role of another character, for example, Lara Croft in Tomb Raider. So, for example, there is Gavin Hewitt, and the computer character Lara Croft - two identities. But there is a third - that is, Gavin Hewitt playing as Lara Croft. Perhaps to be a bit clearer - Gavin Hewitt is the real world me. Lara Croft is the identity created by the game developers who designed Lara with certain abilities and constraints, as well as providing her with a history of sorts - a rich English archaeologist and adventurer who seeks out priceless treasures. Whereas Gavin Hewitt playing as Lara Croft creates this third identity - what Gee calls a “projective identity”. This is where I imbue Lara, as I control the virtual character, with a certain way of acting (whether it be good or bad). Over time I develop hopes and desires for her, and come to define a way in which she explores her world.

Gee sees this tripartite relationship as a key aspect of video games which enable critical learning to occur. Through these internal relationships, and their development and interaction with a set of choices in a virtual world, the player actively engages in reflecting on events, actions and values. Gee also believes that this identification with a character “transcends identification with characters in novels or movies, for instance, because it is both active (the player actively does things) and reflexive, in the sense that once the player has made some choices about the virtual character, the virtual character is now developed in a way that sets certain parameters about what the player can do. The virtual player redounds back on the player and affects his or her future actions” (p. 58)

Students need to make the links between their real world identity and virtual identities in order to enter into and participate in new semiotic domains - that is - to engage actively in the learning process. I consider this point to be very important - that video games provide a mechanism for engaging and encouraging students to move from their real identities into a virtual identity - and that virtual identity offers them the ability to explore their world in new ways.

To sum up Gee’s thoughts, the design and the delivery of curricula is critical to the learning process, and it should be consciously designed to encourage active and critical thinking. Good video games encompass many of the the best theories of learning, and provide the potential to be a very effective tool for the teacher in the classroom.

Assuming this is correct, then it obviously impacts upon the way video games should be developed. A thorough understanding is thus required of what constitutes active and critical thinking, and how it can be supported by video games.
Gee’s understanding of video games as a new literacy is supported by a growing number of texts on the subject.
Issues facing educational game developers

Capability

To understand one of the main issues facing educational game developers in New Zealand, it is first necessary to have some idea of the 3D video game development pipeline. The production of a 3D video game typically involves a large number of people with great artistic and technical skill, working together to bring to life a unified vision. This includes roles such as 3D modellers, 3D texture artists, animators, script writers, level designers, concept artists, shader writers, graphic designers, sound designers, programmers and others. An average game development pipeline would include as many as thirty to fifty persons.

Once a concept has been decided upon, a Game Overview Document is written, which may be anywhere from a few pages to over one hundred, documenting details of concept, technical specifications, game rules, core game-play, the artistic vision, reference material, budgets and production timelines.

Many game developers have a research and development arm, where advances in graphics and game play are exploited to gain a market edge (for example Assassins Creed, 2007 from Ubisoft).

Skills are required in using a wide range of software programmes across a range of artistic and technical disciplines. Game design is truly interdisciplinary.

Common software packages include modelling and animation software like Autodesk 3DMAX or Maya, photo manipulation software like Adobe Photoshop and game engines like Unreal and Torque.

The cost of such productions are in the tens of millions of dollars. Bioshock (2007), a recent first person release from 2K was rumoured to have been in excess of $30 million to produce - however it recouped this with sales of over 1.4 million units. Halo 3 (2007) raked in $170 million on the first day, beating the theatrical release of Spiderman 3, and the sales of the final “Harry Potter” book.

Game development is big business and as such it is unrealistic for New Zealand education to match the development time, cost and quality of these productions.

However, with the advent of game creation programmes, what used to be possible only in the realms of large game development companies, is now possible for small game developers.

An example of such a piece of software is Unity 2. It has recently been released from OverTheEdge, and developed at the IT University of Copenhagen. It supports multiplayer networking, a terrain editor and a web deployable system which can process billions of polygons on the fly. Immersive worlds can be created with a graphics and physics system that rivals the “big boys”. It is to these types of “off the shelf” software titles that I suggest New Zealand developers should look.

This leads me to question whether there are New Zealand educational software developers producing 3D video games specifically with New Zealand content and for the New Zealand education system?

Well, the answer, to the best of my knowledge is yes - but too few - they can be counted on one hand.

Economics and infrastructure

Why are there so few? Mainly as the result of simple economics. Unless development is substantially subsidised by various parties, it is simply not cost-effective to produce such software educational titles - even by keeping costs low with “off the shelf” titles. Development time of a 3D video game generally ranges around 2-3 years. Staff costs are high with no guarantee of success. The New Zealand market is too
small with the only around 336 secondary schools, neither is the Australasian market large enough to lower the production cost per unit ratio to a viable and economic level.

There is of course the further issue of developing software that will actually play on the majority of computers in New Zealand classrooms such is the diversity of computers and computer systems. I heard of a story earlier this year, where a school administrator was very proud to have bought a bulk purchase of computers for very little - not realising that the processing power was extremely limited, and that the school would not be able to run anything more sophisticated than basic software programs. Notably 3D video games require good graphics cards and are RAM hungry - issues most IT directors in schools until now have not had to think about, so getting 3D video games into schools can require significant investment in infrastructure.

To these barriers can be added the misunderstandings and misnomers that surround the “loaded” term of “video games” - bad media press surrounding their supposed promotion of violence, isolation and obesity. As a result teachers quickly put the concept into the “too hard” basket - despite research debunking many of these myths. I have witnessed teachers from several schools bristle with indignation, when the word “video games” and “education” were mentioned in the same sentence.

All these issues that prevent the use of 3D video games in education and need to be faced and solved? Why? Because there is a mounting body of evidence pointing to the value of engaging students and the potential for teaching students critical thinking skills. Included near the end of this document is a list of research books and articles you might like to browse.

My research project undertaken this year does not address this issue. I have simply taken it as a given that there are very compelling reasons for using video games in the classroom.

Games vs. Play
There is of course a debate about the definition of games - and even more debate about the difference between a game and simulations in the new world of 3D technologies. This debate has been the subject of much writing (and no doubt will continue to be), and it is not my intent to cover in-depth here all the aspects to these arguments. However I came across this sentiment early on in the year:

“Games are just play”.

This was said in a negative way. But this observation is exactly right. What many teachers do not realise is that, there is in the act of playing games, a powerful set of conditions that stimulate learning. Gee (2003) comments: “...it turns out that the theory of learning in good video games is close to what I believe are the best theories of learning in cognitive science.” (pg 7)

There are many types of play. There are many types of games. Intrinsically games are a subset of play, and it can be argued that play is also a subset of games. There are also many definitions of games. Salen and Zimmerman (2004) site Chris Crawford, a well known video game designer, as listing four characteristics of games:

**Representation**: A game is a closed formal system that subjectively represents a subset of reality. By “closed” I mean that the game is complete and self-sufficient as a structure. The model world created by the game is internally complete; no reference needed to be made to agents outside of the game. By formal I
mean only that the game has explicit rules. A game’s a collection of parts which interact with each other, often in complex ways. It is a system. A game creates a subjective and deliberately simplified representation of emotional reality.

Interaction: The most fascinating thing about reality is not that it is, or even that it changes, but how it changes, the intricate web-work of cause and effect by which all things are tied together. The only way to properly represent this web-work is to allow the audience to explore its nooks and crannies, to let them generate causes and observe effects. Games provide this interactive element, which is a crucial factor in their appeal.

Conflict: A third element appearing in all games is conflict. Conflict arises naturally from the interaction in a game. The player is actively pursuing some goal. Obstacles prevent him from easily achieving this goal. Conflict is an intrinsic element of all games. It can be direct or indirect, violent or non-violent, but it is always present in any game.

Safety: Conflict implies danger; danger means risk of harm; harm is undesirable. Therefore, a game is an artifice for providing the psychological experiences of conflict and danger while excluding their physical realisations. In short, a game is a safe way to experience reality. More accurately, the results of a game are always less harsh than the situations the game models. (p. 77)

I have mentioned these four concepts because they highlight important principles useful for teaching and learning. Games represent a slice of reality. Video games are made up of “signs.” Salen and Zimmerman (2004) site Charles S. Pierce as considering signs to have four key ideas:

i) A sign represents something other than itself

ii) Signs are interpreted

iii) Meaning results when a sign is interpreted

iv) Context shapes interpretation. (p. 43)

These thoughts align with Gee’s comments on semiotic domains and the importance of learning the literacy of “signs”. Students through the act of playing video games interpret “signs” in order to construct meaning. Games have rules. These rules define the way the game can be played and effect the sense that can made from the game.

Crawford (Salen and Zimmerman, 2004) also mentions cause and effect. This is the game design principle of “Causality”. This ability for players to make choices that have direct and immediate effects within the game structure, allows players to hypothesise and evaluate courses of action. Players can interactively probe and test ideas and concepts without experiencing the harsh realities.

These principles have enormous significance for teaching and learning. The degree to which an educational game design is effective, rests to a large degree upon the quality of choices and effects available to student players. Good game design is essential. Players need to identify the consequences of their actions and feel that these consequence matter.

Games Design Principles
There are numerous books and articles on the subject matter of game design principles, so it would not be possible to recount them all here. “Rather, I thought I would highlight a very few of the general principles of good game design that I think are relevant to education.

**Immersion**

Good game developers bring all game elements together to create the suspension of disbelief. Immersion leads to engagement.

**Causality**

As mentioned above, causality is the relationship between action and consequence. In good games causality is obvious at all times, it allows players to decipher the “rules” and allows them to accept the suspension of disbelief. In educational games it is vital if student players are to make sense of the game world and choose logically between differing courses of action.

**Non-Linearity**
Passive forms of entertainment such as watching movies or reading books create firm boundaries between the audience and the characters. Video games on the other hand do not - there is a blurring of the boundaries between the character and the player. Although most games are by necessity linear in fashion, it is important that the game developers provide the illusion of non-linearity. Players should feel that they are presented with real choices that have real outcome within the game structure.

**Reinforcement**

Reinforcement rewards positive behaviour and punishes negative behaviour through game mechanics. Designers need to be careful that the game mechanics used do not lead to positive feedback loops.

**Learning Curves**

Game designers should balance the need for new information and new game elements with the ability of players to learn, use and apply the new information and game elements in context.

**Replay Value**

Players will consider the game that provides more hours of game time favourably. By using a variety of strategies such as alternate victory strategies, alternate tools or identities and randomised content, players will commit to playing the game multiple times.
A recent example of an educational 3d video game

A recent example of an educational game is “Global Conflicts: Palestine”. This caught my eye because it is has been created using the game engine Unity, was also supported by the IT University of Copenhagen and had input from Simon Egenfeldt-Nielsen, whose papers and research into video games in studying conflict I have been reading. According to Nielsen (as cited in Ivan, 2007) the development funding came from a variety of sources and was around $800,000 Euros.

Simon Egenfeldt-Nielsen holds a degree in psychology and a Ph.D. in computer games and learning. He has written two books about video games and their potential in education.

In Global Conflicts: Palestine you take on the role of a freelance journalist covering some of the issues in Jerusalem. You have the choice of writing for either a Palestinian or Israeli newspaper or for European readers. You must obtain travel and obtain quotes from various personalities in the game reflecting viewpoints from both sides of the conflict. Once you have obtained quotes you compile and submit a story. The most newsworthy story gets the front page, the lesser effort gets the last. The press release kit (Serious Games, 2007) further describes the game: “By interviewing and taking action the students will have an impact on the development in the area and will constantly be forced to relate to their own and other people’s point of view. During their work of collecting information the students will have to make controversial decisions that will challenge their beliefs.”

This game uses a third person perspective. Players look down on the reporter they control and direct his movements to the various personalities. There is a very simple set of controls which allows the player to focus on gathering the information without having to worry about complex command sequences. The learning curve is very easy and the game required students to read and reflect upon various points of view. The game does however use the copy and paste of quotes approach, and for me, this raises questions. From such an approach do we gain the accurate information we require, as teachers, in order to assess our students critical thinking skills? Would it be better if instead of cutting and pasting - students were required to write their own interpretation of conversations? This brings up the previously discussed issue of students expectations when playing a serious game, and how does their expectations affect engagement and learning?

There is an attempt in Global Conflicts: Palestine, to offer students an environment where critical thinking is part and parcel of playing the game, and this must be lauded. It is one of the first video games to be specifically designed with both an educational approach and an interest in studying its practical implementation into a classroom. Nielsen sees the game being integrated into a classroom lesson rather than being “stand alone.” The game was trialled in Danish schools.

Ivan (2007) cites Nielsen as saying: “Even though the game was at a prototype stage, we had three things we wanted to be certain of. Firstly, that students learnt the same or more” in comparison to regular teaching methods, “secondly, that they were more motivated and engaged than traditionally and third, that it would be something they wanted to repeat. Our results found that 60% of students said they learnt more from it than they did from traditional courses and 90% said they would like to do it again in the future.”
Conclusions from playing the demonstration version of the game: The demo version consist of one level called “The checkpoint”. I applaud the creators of this game for putting in all the effort required. I was however disappointed in several aspects, and I would question its broad appeal and engagement. Secondly, the core gameplay was very limited and I was bored after a few minutes. It was only my professional interest that ensured I completed the level. This assessment was supported by several students who also tried the demo version. Playing the whole game and be able to move from one level to another may change this view, but I strongly suspect that this is a case of the pedagogical content sucking the fun out of a game (Falstein, 2007). From an animation tutors point of view, I was also disappointed in the quality of animation and graphics proved disappointing.

However, this game is a prototype, it is intended to be taught in a classroom context, based on Kolb’s experential learning theory (Egenfeldt-Nielsen, 2007) and playing the level out of context provides only limited information. Though some elements were particularly thought provoking - from design details such as the type of graphic user interface used, the artificial intelligence system used on computer driven avatars (a virtual identity represented by a character within a game) to the text based dialogue system.

This experience, made me think seriously about the type of information gathering system I wished to have in “The Gallipoli Experience” and perhaps more importantly the reflective experiences I wish students to have. It also reminded me of magnitude of the task of building this type of gaming experience.

More information about this game can be found at www.globalconflicts.eu
Higher order thinking defined?

Critical Thinking

The term “critical thinking” has been often used this year. Robert J. Sternberg describes critical thinking as “the mental processes, strategies, and representations people use to solve problems, make decisions, and learn new concepts.” Developing active critical and reflective thinking skills in our students has always been the goal of the professional teacher. Over time the words we use to mean this change, but the importance of a teaching thinking skills remain the same.

There is also an increasing awareness of the importance of teaching “higher order thinking” skills. The most obvious pathway when defining “higher order thinking” seemed to be to turn to “Blooms Taxonomy”, (Bloom, 1956) developed at the University of Chicago, in conjunction with his cognitive psychologists. It has sold over a million copies and been translated into many languages. The Taxonomy proposes that any given educational task can be divided into one of three domains: cognitive, affective or psychomotor. The cognitive domain provides a method of measuring a students ability to process and use knowledge in a meaningful manner.

The theoretical value of such a Taxonomy as “Bloom’s” is twofold: it should stimulate teachers to help students acquire skills at all of the various levels, laying the proper foundation for higher levels by first assuring mastery of lower-level objectives; as well as providing a basis for developing strategies to measure and assess student performance at all the levels of learning.

Bloom’s Taxonomy consists of six levels moving from knowledge, comprehension, application, analysis, synthesis to evaluation. The six levels have been further divided into two subsets with “lower order thinking” consisting of knowledge, comprehension and application while “higher order thinking” consists of analysis, synthesis and evaluation.

“Lower order thinking” and “higher order thinking” have also been called “surface learning” and “deep learning”. Biggs and Collis (1982) cite Marton and Säljö as describing a surface approach as involving a:

“minimum engagement with the task and typically focuses on memorisation or applying procedures that do not involve reflection, but aim merely to gain a passing grade.” (p

Whereas the deep approach:

“involves an intention to understand and impose meaning. The student focuses on relations between various aspects of the content, formulates hypotheses or beliefs about the structure of the problem, and relates more to obtaining an intrinsic interest in learning and understanding.”

Marton and Säljö maintain that the quality of outcomes in student learning are directly related to the approach used by the teacher.

Using the Bloom’s Taxonomy
I struggled for some time to understand Blooms. Each level was in isolation though self-evident. However when I tried to relate the various levels with practical game based tasks - it became very difficult. Blooms seemed to be designed to parallel the same instructional teaching methods that are increasingly being seen at odds with the needs of students today.

A quick search on the internet reveals that many Blooms resources have the levels with a series of verbs next to each level. For example the first level of knowledge may have the following list of words, “defines; describes; identifies; knows; labels; lists; matches; names; outlines; recalls; recognises; reproduces; selects and states”. From these words teachers may define activities or tasks that thus require students to operate at this level. It was to such a resource that I turned in order to start form a hypothesis or model for developing strategies for higher order thinking in video games. It was called : “Aim High! Bloom’s Taxonomy Breakdown: Roles, Process Verbs & Products from Bloom’s Taxonomy of the Cognitive Domain” (Nebraska Educators Really Doing Science, 2007).

At the Knowledge Level of the Cognitive Domain. this chart provided a simple definition: recall or recognition of specific information. The Teacher role might be to direct, tell, show, examine, question, evaluate, while the students might be to respond, absorb, remember, recognise, memorise, with the student as a passive recipient. Teachers might set tasks which are in the form of a quiz, a worksheet or test. Students might be expected to list, memorise, relate, show, distinguish, give examples, reproduce and describe.

At the other end of the scale - the Evaluation Level. the definition provided was; judging the values of ideas, materials and methods by developing and applying standards and criteria. The teachers role is to clarify, accept, harmonise and guide, whilst the student judges, disputes, develops as an active participant. Teachers might set tasks such as a report or an editorial in which students express opinions, debate and make recommendations.

The issues with Blooms Taxonomy

Bloom’s Taxonomy (Bloom, 1956) is a contested Taxonomy, yet it is the most widely known and used, despite some issues being raised about its effectiveness as a tool. Teachers at the chalk face want a model that is easily understand and can be applied successfully in a variety of situations. Whilst some say Bloom’s is not the easiest to understand, it is the most familiar model and has become widely used in classrooms in New Zealand.

John Hattie (2007) comments:

*It is thus remarkable that the taxonomy has been subject to so little research or evaluation. Most of the evaluations are philosophical treatises noting, among other criticisms, that there is no evidence for the invariance of these stages, or claiming that the taxonomy is not based on any known theory of learning or teaching.*

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He goes on to say:

*The greatest criticism of the Bloom taxonomy is that there is little evidence supporting the invariance and hierarchical nature of the six levels. Let us recall that Bloom claimed these six levels ‘represent something of a hierarchical order of the different classes of objectives. As we have defined them, the objectives in one class are likely to make use of and be built on the behaviours found in the preceding classes in this list’ (1956, p. 18). A prior condition of the hierarchy is that there is common understanding of the various levels.*

Bloom’s presupposes that a student needs to move through the levels in an ordered fashion, and that before a student could effective evaluate a given context, they must have successfully negotiated, knowledge, comprehension, application, analysis and synthesis.

These very classifications have been questioned for their usefulness as a tool. Calder writes that the:

‘classification filled with nebulous terms (which) makes it impossible to detect similarities in objectives in different subject areas, and frustrates efforts to develop precise principles of teaching and testing bearing on sharply delineated objectives’

Another critic R Ennis (1985) wrote:

*Analysis of a chemical compound,*
*analysis of an argument, analysis of a word, analysis of an opponent’s weaknesses in a basketball game, and analysis of the political situation in South Africa seem like such different activities that we might very well wonder just what we are supposed to teach under the label ‘analysis’*

After some time working with this Taxonomy, the “Initial Education Game Design Premise” was established. This very simple premise was the beginning point of the investigations to follow. It stated that the classifications of cognitive processing provided by Bloom’s: comprehension, application, analysis, synthesis and evaluation, are possible in a video game through the interaction of game play with knowledge. Strictly speaking, the model no longer was a Taxonomy as its levels were no longer accessed via a hierarchy. Therefore a second diagram was developed in an to develop a model that would retain some hierarchical aspects. Although truer to the Bloom’s model this diagram did not offer the potential for students to access levels in anything other than the hierarchical manner. This problem is inherent in the Bloom’s model.

From a pragmatic point of view another one of the dangers when working with such a model as Bloom’s is, in the need to understand and accurately apply the taxonomy to the classroom teachers can loose focus on the process of thinking and learning that is occurring in the students. This was also commented upon when talking with tutors of teachers:

“some people get really stuck on a model and think this is this is the way it should be done instead of stopping and thinking what is really happening with their kids in terms of processing.”
The Bloom’s taxonomy does not provide a measuring tool to judge the outcome of any activity. As assessment is of central concern for teachers, this lack hinders the effectiveness of Bloom’s as a versatile tool. This also became one of the factors in my continued search for another model.

In a conversation with Derek Wenmoth of CORE Education, the SOLO Taxonomy was suggested as just such a possibility. Derek is a very keen and persuasive advocate for this alternative to Bloom’s, and after reading an initial article on the subject, I was attracted by its simplicity. The SOLO Taxonomy, then, became my next subject of investigation.

Figure 5: The second model developed to relate Bloom’s Taxonomy levels to video game development.
According to Biggs and Collis, one model of instruction of the teaching process requires teachers to first decide on a learning “intention”. Biggs and Collis use the term “intention” rather than “objective” as “intentions” are more general than a learning objectives, though they may be the same. In many cases the learning intentions are provided by curriculum statements or department course outlines. For instance an example of a learning intention at level six History of the new New Zealand Curriculum statement: “there are causes and consequences of past events that are of significance to New Zealanders and that shape the lives of people and society.” This statement is general in nature, but is a starting point for a teachers to begin forming content material for students to learn. This then allows curriculum analysis to occur. This involves gathering material and resources, analysing and specifying tasks and defining what would be a successful outcome to meet the above intention. Teachers then, participate in the instructional process - where teachers school students in the classroom. This varies in style and content from teacher to teacher. After instruction, typically some form of task or performance by students is required as an outcome. This provides teachers the opportunity to evaluate whether students understanding fulfil the set learning intention. If this has been successfully met, teachers move to the next learning intention, otherwise devise an alternative process or remedial steps for students to undertake.

For the student, Biggs and Collis suggest the process starts with the students intentions. These intentions may or may not be the same as the teachers. Students also bring prior knowledge to the instructional process which impacts upon the learners intentions, curriculum analysis, instructional processes, the outcome, the student’s own learning processes and the learners own intentions. The learning processes itself includes numerous factors. These may include the students ability, developmental stage, working memory capacity, learning and problem solving strategies, and others outlined by Biggs and Collis. Student also evaluate their own learning, though this is often informal and implicit - but the outcome determine future motivations.

Biggs and Collis suggest this model is similar to Glaser’s model of instruction. This process is used to teach “closed” subject matter, where “the whole teaching process breaks down into a sequence of activities, from goal setting, content and task selection, procedure, and evaluation, with any mismatch between outcome and intention being attributable to a breakdown at any one or more of the teaching steps.” (pg 12)

Collis suggest that the quantity and quality of learning are determined by the interrelationship between these teaching and learning processes, and then asked two fundamental questions, both of which are directly relevant to my research question. They were: “How do we measure learning quality? and second: How can we boost quality, once we can measure it?” (pg 12). They determined “there is an urgent need for qualitative criteria of learning that have formative as well as summative value”. (pg 15)

The SOLO Taxonomy is a response to the first question, and can be used to help answer the second. It was based on how teachers teach and how students learn, by developing “their model from a study of learning objectives and found that students learn quite diverse material in stages of ascending structural complexity that display a similar sequence across tasks”. (Hattie)

The SOLO Taxonomy itself, can best be described by an extract from Hattie and Purdies “The Power of the Solo Model to address Fundamental Issues”:
The taxonomy makes it possible, in the course of learning a subject, to identify in broad terms the stage at which a student is currently operating. In this consistent sequence, or cycle, the following stages occur:

**Prestructural.** There is a preliminary preparation, but the task itself is not attacked in any appropriate way.

**Unistructural.** One aspect of a task is picked up or understood serially, and there is no relationship of facts and ideas.

**Multistructural.** Two or more aspects of a task are picked up or understood serially, but are not interrelated.

**Relational.** Several aspects are integrated so that the whole has a coherent structure and meaning.

**Extended Abstract.** That coherent whole is generalised to a higher level of abstraction.

Further, they write:

*Such learning develops in a hierarchy of levels of increasing structural complexity.*

The levels are ordered in terms of various characteristics:

- from the concrete to the abstract
- an increasing number of organising dimensions
- increasing consistency; and
- the use or organising principles or relating principles

Hattie and Purdie then describe four characteristics of the SOLO levels:

**Capacity.** Each level of the SOLO taxonomy refers to a demand on amount of working memory or attention span. For example, at the unistructural and multistructural levels, a student need only encode the given information and may use a recall strategy to provide an answer. At the relational or extended abstract level, a student needs to think about more things at once.

**Relationship.** Each level of the SOLO refers to a way in which the question and the response interrelate. A unistructural response involves generalising only in term of one aspect and thus there is little or no relationship involved. The multistructural level involves relationship in terms of a few limited and independent aspects. At the relational level, the student needs to generalise within an given or experienced context, and at the extended abstract level, the student needs to generalise to situations not experienced.

**Consistency and Closure.** These refer to two opposing needs felt by the learner. On the one hand, the student wants to come to a conclusion and thus answer the question. But on the other hand, the student wants to be consistent so that there is no contradiction between the question and the answer. Often when there is a greater need for closure, then less information is utilised, whereas a high level of consistency is required to utilise more information when conceiving an answer. At the unistructural level, the student often seized on immediate recall information, but at the extended abstract level, the student leaves room for inconsistency across contexts.

**Structure.** The unistructural response takes one relevant piece of information to link the question to the answer. The multistructural response takes several. The relational response makes more use of an underlying conceptual
structure and the extended abstract requires more structure so that the student can demonstrate that he or she can de-
duce answers beyond the original context.

The SOLO Taxonomy across different curriculum areas

One feature of the SOLO model (Hattie and Brown, 2004) is its ability to be used successfully across
different curriculum areas. Biggs and Collis (1984) spend some time expounding upon this very theme,
writing five chapters covering the content areas of History, Elementary Mathematics, English, Geography
and Modern Languages. In the history section, they worked with six different situations common in teach-
ing history. These are:

1. Drawing conclusions from a display of information (e.g., a lesson, an original document)
2. Making value judgements about a historic event
3. Reconciling conflicting evidence from different sources
4. Constructing a plausible interpretation from incomplete data
5. Understanding historical terms and social concepts
6. Inducing the meaning of a concept from a context (p. 35)

These by no means represent the sum total of possible situations, but were used throughout the
chapter as a means to begin exploring interactions between history and the SOLO Taxonomy. Biggs and
Collis (1984) take each of the six situations one at a time, and pose a hypothetical context and ask questions
at various levels of the taxonomy. An edited extract from this book shows how easy and accessible to
SOLO Taxonomy is.

For the situation of “Making value judgements about a historical event” (Bigg and Collis, 1984) a
passage was given that describes the Norman conquest of England in 1066. The question was asked: “Do
you think William was cruel?” (p. 42)

Biggs and Collis provide examples of student answers that can be classified into one of the four cate-
gories (excluding prestructural)

Prestructural: “I think William was cruel because it says that men, women and children died
there.” (p. 42)

This is an example where a student answers the question based on the location of one fact.

Multistructural: “Yes, I think William was cruel because it says he carried out a terrible revenge, burning the
houses and killing the people and animals.” (p. 42)

Here the student has chosen a single closed viewpoint based on several facts.

Relational: “William was cruel because he destroyed the land and caused a famine but the English and the
Danes had destroyed his garrison. He also allowed the people to collect the bodies of the people they wanted to
bury.” (What does this prove then?) “He could be cruel in winning a battle but after a battle was over he could allow
the people a little more scope.” (p. 42)

Biggs and Collis cite this response as illustrating:
that even though the student is capable of giving two sides of the question, he still requires closure. It is a qualified closure which relates the inherent conflict (cruelty to battle). However, he has confined himself specifically to the data...” (p. 43)

Whereas this response from an extended abstract level starts with a hypothesis, explores given data and then draws information from outside before providing a qualified conclusion:

Extended Abstract; “It depends on what you call cruel. If the definition of cruel is to kill and ravage and burn for any purpose whatever, William was cruel. On the other hand, if one is prepared to accept political necessity, William’s cruelty was justified. Compared with many other feudal lords he was essentially a kind man. They ravaged generally for their own advantage and without care for the common folk or their land. Duke William, if the common people went with them, seems to have been prepared to protect the common people from ravages. If, however they went against him he seems to have treated it as a deliberate breaking of faith and acted accordingly. So, by the standards of his own day, for we cannot really judge him by our standards, he was probably not a cruel man.” (p. 43)

What became apparent from these passages was that the SOLO Taxonomy can be used as a tool to not only develop questions, but to assess responses.

This highlighted a potential problem with the Bloom’s Taxonomy (Bloom, 1956). A Bloom’s question asked at the Knowledge level supposes a response at that level, whereas under the SOLO taxonomy, any question asked could have a range of responses from unistructural to extended abstract. This seems to be to mirror my experience in the classrooms (not surprisingly as the SOLO taxonomy was developed out of ordering classroom responses).

Biggs and Collis (1984) write:

“The SOLO Taxonomy is, as far as we are aware, the only instrument available for assessing quality retrospectively in an objective and systematic way that is also easily understandable both by teacher and student. For this reason, the Taxonomy may be used as an instructional as well as an evaluation tool.” (p. xi)

It is for this ability to be used as a tool in developing instructional material that the SOLO Taxonomy appealed.

However, before I examine how the SOLO Taxonomy was applied to the process of developing educational video games, I will provide a brief overview on what Biggs and Collis (1984) have to say about the SOLO Taxonomy and instructional design.

There are two outcomes that academics desire for their students: “The assimilation and understanding of the content of the subject (i.e., the facts and concepts that constitute knowledge of the subject); and the cognitive processes that are induced by a proper understanding and application of the subject (i.e., the skills and strategies that constitute the appropriate way of thinking for that subject).” (p. 164) They go onto comment that there are basic process and content elements that make a subject, and make the point that throughout the schooling process a student should understand and assimilate these codes in a cumulative fashion. Therefore at senior levels of schooling students may be expected to operate at an extended abstract level of the SOLO Taxonomy - though this is “an unrealistic goal in the high school curriculum for many students.” (p. 164) At junior levels of the school, a multistructural level of understanding might be sufficient.
Biggs and Collis (1984) point out that the SOLO Taxonomy can be used to provide an index of structural complexity, and this is useful in instructional design - in other words a hierarchy. This requires then that teachers should be aware of the content and processes they wish to teach, and develop instructional material that spans each level of the SOLO Taxonomy. A thorough knowledge of the subject and the curriculum is thus demanded.

Hattie and Purdie (2007) has designed a flow chart: Devising a Solo Taxonomy Testlet, (Figure 6) that has been very useful, to indicate the steps a teacher might go through in developing instructional material.
Figure 6. Devising a SOLO Taxonomy Testlet as devised by John Hattie and Nola Purdie
Using the SOLO Taxonomy as a model for devising educational game based learning strategies

The SOLO Taxonomy “Testlet”

The “Testlet” approach developed by Hattie and Purdie (2007) was to become the basis for my hypothetical model on how to develop video game strategies that would encourage higher order thinking, the fourth stage of the Soft Systems Methodology (Checkland, 1981) - Conceptual models of the systems, intended as improvements, are developed. This step by step “testlet” process was adapted to become the chart “Devising In Game Content for A Solo Taxonomy Testlet”.

This process now allowed for the inclusion of video game data and strategies that would provide the students with resources with which to answer questions at each level of the taxonomy.

The next stage was to follow this revised process and see if it was workable. Being aware that the phrasing was still very general in nature, and the type of video game strategies open, I was keen to see this process trialed and refined. This then became the next focus of the research.

Step One was to “Decide on a learning intention related to the chosen context” that would illustrate both the potential of this model as well as any deficits.
Figure 7: The revised SOLO Taxonomy testlet modified to accommodate video game development.
Authentic contexts

Our Stories

Adoption of aspects of culture from sources outside of our own, is not new - neither is the desire to preserve culture from generation to generation. In recent years there has been a drive to pursue our “own voice” in the media. The New Zealand book scene is more prolific than ever, New Zealand music is being pushed actively on radio and by music publishers, and New Zealand film has produced internationally acclaimed stories based in New Zealand culture such as Witi Ihimeras “The Whale Rider”. New Zealanders seem more than ever, keen to hear their own stories. New Zealand stories are represented in all artistic forms of expression - except 3D video games.

In the video games industry, an industry that eclipses Hollywood in terms of revenue, there are few New Zealand stories, if any at all. There are many reasons for this - mostly based on economics. New Zealand does not possess a large enough market. New Zealand does however, possess a small number of successful New Zealand game developers - of these the most notable is Sidhe Interactive. For them, success has arrived on the back of titles with strong international appeal - such as “GripShift”. Of course one could argue that the video games culture is an international culture - and that gamers are increasingly part of the global online community where borders and cultures are being redefined - and this would be true. But what of our own New Zealand stories?

Is there a place for New Zealand stories within 3D video games? Can gaming technologies be used to ensure cultures and traditions can be recorded and experienced by young New Zealanders?

These are the sorts of questions that I have been pondering over the last year or so. I do not have all the answers, or even all the questions. But what I do have, is a passion for trying to find out if it is possible to use gaming technologies in a New Zealand context.

So in thinking about developing a game for the research fellowship, I was convinced it should be based on one of “our stories”. An authentic New Zealand story. I settled on the story of Gallipoli.

Why Gallipoli?

While attending Palmerston North Boys’ High School, where the story of Gallipoli and New Zealand’s sacrifice as a young nation throughout the first World War was vividly brought to life every ANZAC day, as the roll of the dead of all the old boys was read out whilst the students stood to attention. It struck me then, how young and full of energy these young men must have been - and the cost New Zealand paid.

When I was 20, I travelled overseas to various countries of interest. One country high on the agenda was Turkey. I wanted to see the Gallipoli peninsula and experience what it must have been like looking up at the cliffs, coming ashore on the morning of April 25th, 1915. The experience was a moving one and was nothing like I had imagined it. Dense scrub, incredibly hot (I was there during one of the worst heat-waves on record) and a tough rugged countryside. I walked through some of the trenches and saw the odd spent bullet cartridge still half covered in the earth and through the many rows of headstones in the cemeteries. One inscription I recall, even today, some twenty years later - “A mother’s thoughts often wander to this sad and lonely grave.” It was to be an experience that would be embedded on my consciousness.
When mentioning that I intended to use the Gallipoli story as the context for my research, I have often been asked “So, you are making a war game?” to which I reply “No, I am making a history game”.

I was also reminded very early on in the year I was reminded that history is about real characters, real peoples lives, and that the tragedies that occurred still affect living relatives. This is illustrated by the following episode:

One time my wireless Internet connection in my home office was causing trouble. Finally, after trying to sort out the issues myself, and failing miserably, I was persuaded by my wife to hire a professional. On the day this person came, I was working on creating the terrain for Anzac Cove. I had various maps and books scattered over the office, and had just applied a basic texture map to the mesh, so the landscape of the cove on the monitor was starting to come to life. After a few moments of pleasantries, the technician asked what I was working on, “Was it Anzac Cove?” Upon my reply of “Yes” I proceeded to explain in the briefest of terms what I was undertaking this year, least his eyes became glazed over and he politely excused himself and completed the work in a hurried manner... Instead, to my surprise, he was genuinely interested and exclaimed “It is about time this sort of thing was being done...” It transpired that his great uncle was Jack Dunn, and his father, Mr Pat White, had written a book (White, 2005) based on Jacks diaries -so he was very familiar with the Gallipoli campaign.

The previous week I had been devouring “Quinn's Post, Anzac, Gallipoli” (Stanley, 2005) and had only just read the story of Jack Dunn. Jack was a private in the Wellington’s machine gun section. Machine gunners were unable to have regular spells away from the firing line as there were so few trained gunners. After eight weeks in the front line, they were described as “nothing but skin and bone”. In mid July - Dunn had reported sick with dysentery, but stayed on duty. He was seen by one of the officers asleep at his post, and was charged. On the 18th of July, 1915, Dunn appeared before a Field General Court Martial held on the slopes behind Quinn's Post. He was found guilty, and sentenced to death by firing squad. Falling asleep was becoming quite a common occurrence as the ill health and stress took their toll. Dunn was to be an example. He was also to be the only New Zealander at Gallipoli to receive the death sentence, the first of 28 New Zealand soldiers during World War 1. It was nearly two weeks later, that he found out that General Godley had commuted the sentence to ten years hard labour. In fact, Jack had discharged himself from the doctors care to be back with his mates manning their machine guns, and was due to be relieved over an hour before he fell asleep. Jack remained on active service with the Wellington Battalion, and was killed in the attack on Chunuk Bair in early August. Jack had survived less than a week after hearing of his reprieve.

Although I am no historian, I am keenly interested in history. This was the first time that I really understood how history is personal. Jack’s family back in New Zealand did not talk about the events. It was a subject that was a no-go-area for many years...

For many New Zealanders, war histories are also found locked away in the memories of our older relatives... for some, rarely talked about. For many families they are now lost.
A: ANZAC Cove in daylight showing Watson’s Pier. The texturing does not include “baked” shadows to enhance the graphic quality. This would occur once all game asset positions have been decided.

B: Table showing interactive documents at ANZAC HQ, Godley Terrace.

D: Bully Beef cans with flies swarming around. The Map on the table is interactive and provides information to the ANZAC sectors and the location of Quinn’s Post.
Around a table, at a family gathering this year, I also discovered that my wife's family had a strong connection to the events at Gallipoli. It was, once again, discussions about what I was currently working on that prompted the information to surface from my wife's grandmother. Her father had fought at Gallipoli. He was one of the youngest New Zealand soldiers there, being only 16. Although he survived the experience, and continued to fight with the first New Zealand Expeditionary Force in France, upon his return home it was clear he had changed forever, and his family were to share in the consequences...

The number of memorials to the fallen in World War One, are a reminder of the heavy price New Zealand communities paid. Upon the entrance to my daughters primary school stands once such memorial, recently cleaned and repaired. On it are the names of 155 pupils who lost their lives. Whilst in the corridors of Hagley Community College, hangs the portrait of Lieutenant W. B. Rule, killed at Passchendaele. Throughout New Zealand any road trip will see you pass through local communities who have in some way marked the fallen. The story of Gallipoli is personal. Gallipoli was the beginning of a national trauma, whose scars can still be traced across both lives and land.
The ANZAC Game

The Gallipoli Game Overview Document

The Game Overview Document (GOD Document) is the blueprint of the game. It is both wide in breadth and rich in detail. It is the document that establishes all facets of the game, from characters, assets required, to simulation mechanics and technical requirements. These documents are typically large.

For the purposes of this research, I choose not to create a detailed 30-40 page document. However to indicate a hypothetical game structure I have included the main objectives of the initial levels of the game, below:

Level One

Players take on the role a young soldier called “Thomas Everton” who has been assigned the job of reporting directly to the New Zealand Defence Minister Sir James Allen.

The player arrives at Watson’s Pier, Anzac Cove on the night of May 30th, at 11pm. The beach is a hive of activity, and the sounds of gunfire and explosions fill the air. The scene is lit up periodically by the flashes of the enemy guns. A sortie is taking place from the firing line at Quinn’s Post.

Objective One: (accessed via loading screen) Find Godley Terrace and report to ANZAC HQ, locate the officer in charge. The player is directed to find lodgings in a dugout and check in at signals.

Objective Two: (accessed via NPC (Non-Player Character)) Locate necessary items... empty journal, pack, map, compass, food supply

Objective Three: (At signals) Message from Sir James Allen arrives - “Go to Quinn’s Post and appraise yourself of the situation at the front forthwith. Respond with your written assessment as to their present position and morale.”

Level Two

Players undertake the journey to Quinn’s Post during daylight hours. The player is exposed to sniper fire and experiences the terrain and conditions.

Objective One: (accessed via loading screen) Report to HQ Quinn’s Post. Find Colonel Malone.

Objective Two: (accessed via NPC) Report to the firing line. Find the Turkish prisoners and assist in their transport to Anzac Cove.

Objective Three: (accessed via NPC) Reach the Anzac Cove internment camp successfully with the Turkish Prisoners

Level Three

Objective One: Assist Officers with the interrogation of the Turkish prisoners. Forward a written report to Sir James Allen detailing the Turkish soldiers condition, willingness and capacity to continue to fight. Outline the Turkish perspective on the war.
Level Four

Objective One: (accessed via loading screen) Report back to Colonel Malone, Quinn’s Post. Carry items that may be of use at the front.

Objective Two: (accessed via NPC) Repel Turkish attack.

Objective Three: (accessed via NPC) Keep wounded soldier alive and escort him to the nearest cleaning station

Level Five

Objective One: (accessed via NPC) Escort the wounded from the clearing station to Anzac Cove and evacuation.

Objective Two: (accessed via NPC) Write a letter home on behalf of the wounded soldier. Objective Three: (accessed via NPC) Return to Anzac Cove Quarters.

These five levels are sufficient for the purposes of this research, however, they are a linear construction. This linear approach is pretty much a necessity in narrative formats and is common in older style first-person games. However there is now a real attempt to hide this reality and provide the illusion of non-linearity. This is achieved through a variety of methods, including the “choose you own adventure” formula of children’s books, game-play mechanics and increased realism of AI scripts. The intent is to create an environment when players feel they have real choices, and are not simply a puppet on a string. This illusion aids engagement and focus within first person video games.
A: Box Modelling: models are extruded from a simple box in order to create a complex shape.

B: Lee Enfield Rifle

C: Various models created to scale

D: The Canteen’s mesh has been made to look smoother by softening Normals. The shape of each model needs to be created with the minimum number of polygons, as illustrated by the mesh of the 1914 era camera.

E: Each item has to be unfolded to create a UV Layout. UV layouts are like a modelling decal sheet where you can paint textures.
The importance of immersion and interactivity

Immersion

For the purposes of this research immersion is defined (Laramée, 2002) as “the suspension of disbelief”, a “state in which the players mind forgets that it is subject to entertainment and instead accepts that what it perceives as reality.” (p. 61). Immersive game strategies are used to draw the player in help players identify with the role of character they are playing - forging a strong connection with the game. Immersion is required in order to address James Paul Gee’s “Identity Principle”, mentioned earlier.

This suspension of disbelief does not necessarily require large amounts of sensory stimulation, as people have been “lost” in a good tale since the inception of language. Creating immersion though, has become a fine art for game developers, and there have been complaints that games do this too well - they engage players in too powerful a way. This engagement however, is one of the precursors to a good learning experience. (Gee, 2003). Games create immersion in a variety of ways, through such techniques as sensory input, realistic graphics, positional audio and dramatic acting. A good game developer will include enough detail in a virtual world to ensure the player is engaged in the experience, but not too much information that the player feels overwhelmed and gives up.

Interactivity in a video game is defined simply as the “stuff that players do” inside the game world. Activities take on numerous forms, from (in “Call of Duty 2”) firing a weapon, crouching or jumping, to throwing a grenade or driving a tank. All these in-game abilities are designed as an abstraction of real world events. Many of them are embedded so deep into the history and culture of games that players accept logically absurd abstractions - for instance in-game health systems.

Interactivity is incredibly important in educational video games as it is through the types of things that a player / student can do, that they learn. Interactivity provides choices, and choices provide opportunities for critical thinking and reflection. (Gee, 2003). This importance of meaningful choices in a video game cannot be underscored enough.

Game strategies in existing commercial games that may be useful in the Gallipoli Game

Several games which have been examined during research this year may be considered to possess in-game strategies that could be utilised for educational purposes. These games included a popular “first person shooter” “Call of Duty 2”, a puzzle video game “Myst” and a role playing game called “Oblivion: The Elder Scrolls”.

“Call of Duty 2” is produced by Asphyr, and was the sequel to the game of the year in 2004. As you progress through the game you take on the role of three different personalities, VV a Russian soldier fighting on the eastern front, BB, a British soldier fighting in the desert campaigns of North Africa, and NN an American soldier at the Normandy landings.

Immersion is built in the first person genre by numerous methods. The Game user interface is carefully designed to give all the tools necessary to play the game (game controls and feedback) while keeping the need to access them to a minimum. Too many graphic user interface controls and the tightrope of immersion is broken.

Listed below are several of the types of strategies that could be employed from video games studied, in a history based simulation such as “The Gallipoli Experience”.

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**First Person Perspective**

The First Person perspective is one of the most common perspectives used in games and are found primarily in the “First Person Shooter”. This is an abstraction in which the player views the virtual world through the eyes of his character, seeing what the virtual character sees - the player “becomes” the character. It is also seen commonly in racing game simulations. This choice of a player’s perspective was made early on in the development of the game overview document, as it affects the elements of game design profoundly. There are downsides to using a first person perspective - perhaps one of the greatest is by using the first person style controller, the game or simulation will be automatically judged against other First Person Shooters (FPS) games, of which there are many.

**Contextual on screen prompts**

As players move throughout the game there are a number of controls that players need to know. Instead of requiring players to memorise all the keyboard commands prior to playing the game, game developers have developed a system whereby hints or instructions appear on the screen only when the player needs to know.

**Compass**

A compass is on screen at all times in “Call of Duty 2”. It serves multiple purposes. It is used as a guide to orientating yourself to true North and thus find your way around - however it also shows the direction of the current objective through the use of a yellow star, as well as other members of your unit indicated by green arrows or the enemy by red arrows.

**Objectives**

Objectives can be updated as the player moves through the game, ensuring players only focus on one goal at a time. When an objective is reached, a new one is given via written instructions at the top left of the screen. Objects can indicate an objective reached by use of colour. For instance, players need to locate explosives and take them to the correct location in order to destroy a building. When the explosives have been collected and the location has been reached, the explosives appear in yellow indicating the explosives are ready to be fired. A keyboard hint appears “Press F to plant explosives”. Once this is done, the player has limited time to vacate the vicinity before the building blows up.

**Dialogue Systems**

Systems for creating dialogue between characters are commonly found in role playing games. The characters can be either other humans playing an avatar (in a networked environment), or an NPC (Non-player character). It is often used as a way to provide the player with necessary information in order to complete tasks. These systems have evolved to sophisticated levels providing a greater variance of responses and illusion of intelligence.

Typically the player has a choice of questions to ask a NPC, and the answer responds accordingly. These interactions can become very complicated very quickly, but give the player a greater sense of purpose and control in the game. Excellent examples are found in “Oblivion: The Elder Scrolls”

**Health Systems**
There are various types of health systems in games, and as mentioned before are an example of a game world abstraction that is extreme. Health systems can be traced back in the history of games to role playing board games, where “hit” points were allocated to various characters and scenarios. This concept has become very common in its modern form of health bars. Health systems are useful in that they provide a sense of tension to a game - the possibility of death is now present. It is through health systems that players now have the challenge of staying “alive” as they set out to accomplish their task or mission.

Laramée (2002) cites Johnathon Schilpp as commenting on these features common to many hit point systems:

- Each character is assigned a certain number of hit points
- When something occurs that “harms” the character, some of these points are lost.
- The more harmful the source of injury, the more points are lost
- If the number of hit points reaches zero, the character dies
- It is usually possible for the character to be healed through various means, in which case the number of hit points for the character increases
- There is a ceiling to the number of hit points which may be gained through healing, which is usually equal to the character’s original assigned number of hit points
- To simulate character growth, the character’s maximum number of hit points is periodically increased. This increase makes the character less vulnerable and rewards the player as well. (p. 96)

Closely aligned with the concept of health systems are the abstraction of “power ups”. “Power ups” are often scattered throughout levels in the FPS genre, and are designed to sustain the players ability to keep playing the game. Essentially a “power up” is a quick health fix - so when a players health is dangerously low a player can locate and run over a health pack and be restored to various degrees of health. Some times these “power ups” are health based, other times they use the abstraction of energy shields or the like.

The Inventory System

Inventories are game abstractions that allow players to inherit skills or abilities based on the tools or weapons they have collected. These are very common across a number of video game genres and do not interfere overly with the suspension of disbelief. There are a number of design solutions for interacting with inventories ranging from scrolling icons to a context sensitive inventory where the player never has to make a conscious decision to use a tool, instead the computer detects the situation and provides the player with the appropriate tool.

The advantage of an inventory system is that it provides the player with options and choices during game play. Interesting scenarios can be developed like in the “Halo” series where players have an option of a variety of weapons but can only carry two at any one time.

Bread-crumbing and Level Design
Game developers use several types of devices to ensure players only have access to certain areas of the level. Players are usually constrained by logical level design - a road block here, a fallen building there, a raging fire or a mine field. Add to this the strategy of “Bread-crumbing” - that is enticing the player along a certain path by placing extra ammo, health or different types of weapons. This leading of the player may also be accomplished through narrative structures. These types of war games to date have been by necessity very linear. You start at one point, move to another, progressing through the levels by achieving goals. The trick for designers has been to try to design the levels and game play in such a way that the player does not notice this linearity, or if they do, they accept its logic.

One of the powerful features of video games for student learners is this ability for the game to deliver fast effective feedback. A rudimentary example of this in “Call of Duty 2” is the device whereby when you are hit by enemy fire the screen turns a dark red over time as if your vision is fading. An onscreen hint appears saying “You are hurt, get to cover!” providing an opportunity to move out of harms way and recover from your wounds.

Cinematics and Animations

Cinematics, essentially a mini movie, is a common method to provide important information to the player whilst at the same time loading digital assets for the next level. These are also used in-game in an expansive level for the same purpose. Set character animations are also used in games as a method to convey information. The adventure Game “Myst V: End of Ages” uses character monologues extensively to develop themes and provide clues to the mystery.
Ethics

In the course of developing strategies for the game several ethical issues arose. One such concern occurred around the potentially sensitive issue of gravestones. The question arose – should actual names be shown on the stones. Burial at Gallipoli was often a hasty affair with little more than a few stones, or discarded wood being used to mark graves and many were lost prior to exhumation in 1919. Those that remained identifiable become part of the charge of the Commonwealth Graves Commission. The subsequent information therefore is in the public domain.

Initially the idea was for the player to be able to click on a grave-marker and be taken to a biography of the deceased. This was important in relating that Gallipoli is a human story, with students needing to make the connections between the sacrifice of young men in 1915, themselves and the local community. Also the idea of subverting the perception that video games are about violence and desensitise players to the meaning of death and destruction became appealing. By creating a connection between players and the events that result in some empathy, the game would achieving something worthwhile.

The conundrum of whether or not families of the soldiers wish their loved ones to be incorporated into a video game, albeit an education video game remained? I suspected that many may not - leading to the development of a more general approach. The ideal situation of course would be to have the time and resources to talk to families and gain permission. This may still happen if the game is to be developed further, thereby personalising the story and recording the sacrifice of New Zealanders.

How to do you create a 3d video game that remains faithful to the story of and consequences of Gallipoli? In one sense, developing a 3D game on such a topic, is no different from writing a play or directing a movie. Both of which have been done (Shadbolt, 1982 and Weir, 1981). Such examples and information presented to the viewer / participant needed to be selected and edited in some way to inform with integrity.

However, it can be argued that there is a fundamental difference between the experiences of watching a play or viewing a movie, when compare to playing a game. While both plays and movies are passive, playing video games require active participation.

James Paul Gee, (Gee, 2003) argues that passive learning will not provide students with the type of skills required in the contemporary world. Rather, active, critical thinking that is participatory, is required. This necessitates information to be repurposed for interactivity and digital transmission.

So how much do we change history in repurposing content for 3d consumption? By allowing players to access information outlining some of the causes and events that led up to the Gallipoli campaign, as well as access to its goals and reasons for failure provides for informed opinion. Players then, in their assumed identity, are privy to information that would have only been available to a few selected individuals or not at all.

A search through papers that may have been available at the time exposed some very interesting articles on the beach landings. Such papers certainly found their way to the front, but took some months to get there. In the end the decision was made that re-purposing certain forms of information was legitimate as an educational tool - as long as it was transparent. Consequently an article for the fictious newspaper...
“The Wellingtonian” was developed outlining events leading up to the campaign, along with Churchill’s plan to force the Narrows.

There is always a tension between trying to be authentic and accurate, balanced by the need to convey information to a contemporary audience. The New Zealand History Curriculum (Ministry of Education, 2007) requires students to:

“Understand that the causes, consequences, and explanations of historical events that are of significance to New Zealanders are complex and how and why they are contested.” (Level Eight Achievement Objective).

On a visit to the New Zealand Army Museum at Waiouru, I had a very interesting conversation with the archivist. In essence the archivist holds the position that any historical document should be recorded and published in its entirety to retain the integrity and veracity of the document. The context of the document plays a large part in supporting this veracity. Many instances repurposing documents for inclusion into a 3D environment require the breaking down of the document into parts, thereby disconnecting them from their original context, and thus reducing its value.

This is an interesting issue for educational 3D video game developers to be aware of and engage with.

Just as a side note to the conversation with the Archivist - the digital age is making it very difficult to retain New Zealand’s personal histories. Where soldiers once wrote letters home that became treasured heirlooms to be passed onto the museum, now e-mails are sent that are never permanently stored for posterity.
Referencing authentic images

A priority in developing 3D video game for educational use is the desire to create authentic contexts that are faithful to the learning experience. For “The Gallipoli Experience” it means faithful replication of learning materials - from historical writings, oral histories to objects, environments and sounds. All the rich detail that makes an environment and experience believable.

Many of the documents have been referenced from published manuscripts. Educational use of such material is allowed under copyright law, but there is a potential issue over repurposing material into a digital format. For the purposes of this research small samples were taken from various documents. As the game product itself, will not be released this should not present a problem. However, the copyright issue will need to be investigated and addressed by lawyers before a functioning educational resource can be released.

Fortunately, there is a wealth of photographic research material available about Gallipoli. Sources for these included: The Canterbury Public Library; The University of Canterbury Library; The Canterbury Museum Archive Department; The New Zealand Army Museum Library; The Imperial War Museum online photographic collection and The Australian War Memorial online photographic collection.

Images from these sources have been used to model and create in 3D various items, consequently creating no entanglements with copyright law. The replication of photographs however is a different matter. All libraries charge various prices for the use of the photographs under their care. They range dramatically in accessibility, quality, service provided and cost. Some institutions place strict conditions on what you can and cannot be done with a photograph. For example The Alexander Turnbull Library has tight conditions on the cropping of photographic images, and many of these conditions do not allow for repurposing images for 3D content or delivery systems.

Many photographs simply did not provide enough information in themselves to recreate an object in three dimensions. An example of this is the model of an authentic first world war field telephone. Although several photographs were sourced from the internet they did not provide the level of detail required - so modelling required some assumptions. This lack of detail was common - even on the most common of objects.
A visit to the Omaka Aviation Heritage Centre, provided an opportunity to take photographs of first world war uniforms from multiple perspectives. The museum contains many wonderful exhibits created by Weta Workshop, including a scene of Manfred von Richthofen’s last flight, in which Australian soldiers tear the plane apart for souvenirs.

Similarly a visit to the Waioru Army Museum proved useful. A number of artifacts on display provided answers to questions that had already been posed in the process of creating 3d Models.

What became clear is that “The Gallipoli Experience” was to become a commercial product, there would need to be a sizeable budget in order to manage the significant complexity involved in the legalities of copyright.
A: The Unity game engine interface, showing the Scene, Hierarchy, Project and Inspector View. This is where the models, textures and animation are all put together and made interactive with drop and drag scripts.

B: The water barrel with the Box collider. The careful placement of these colliders trigger events when the player moves through them.

C: The First-Person Controller (player) with the Camera field of view.

D: The custom script “Handle Object” displayed in the Inspector.

E: The terrain as seen in the Scene view.
Building the Game

A brief overview of the process

Once reference material was gained and a list of digital assets was compiled, it was time to start modelling.

The first task was to model the terrain at Anzac Cove. This proved a little more difficult than I had at first thought. I had hoped to acquire a digital elevation map (DEM) file which is essentially a digitally encoded file with information regarding the height and disposition of terrain. These are interpreted by 3D software and produce an accurate mesh. Although these are common enough file types, the quality of those available for Turkey were too limiting. This required the construction of the mesh to be made individually from hand, using Maya’s 3D sculpting tool and using photographs for reference. This is not as easy as it seems, as not all areas were referenced thus requiring assumptions to be made in order to complete the mesh.

To populate this environment Watson’s Wharf was built, as were numerous items that filled Anzac Cove, ranging from Bully Beef supplies to horse drawn carts. Notably the general layout for Godley Terrace was modelled on a photograph located from the Canterbury Museum Gibson collection of Anzac photographs.

Each item had to be modelled separately by extruding polygon surfaces with reference to authentic photographs. This method used is called “box modelling” and consists of extruding the surfaces of cubes until they match the final shape required. Maya has an excellent polygon toolset which makes achieving the desired look possible.
Once modelled the item needs to have appropriate textures applied. The display of these textures are controlled by UV sets. Although these can be generated automatically, it was found that it was important to delete the automatic set and designate my own set. This ensures that the areas of most interest to me (for instance a logo) can have prominence and retain quality. Textures require careful planning so that they are not wasteful on computer resources and maximise the UV space, otherwise they slow the video game down. Using Adobe Photoshop textures were created from a photographic source where possible and involved many hours of work for each item. Each model consists of one texture decal sheet. These are applied within the Unity game engine with an appropriate shader that controls the material itself. This allows some variance in surface detail - so metal can reflect in game lights and show specular highlights where as cloth may have soft diffused light. This attention to graphic quality aids the “suspension of disbelief” required to draw the player into the world.

Some models require elementary animation, for instance the health kit. Essentially, the .mb (maya binary) file is given a box collider in Unity. When in the game a player moves onto this collider the animation on the model is triggered by script. This triggering of events is used often throughout the game.

Scripts in Unity are based on the javascript programming language. Although the tutorials given with the Unity game engine are called “beginner” and “easy to follow” - they are not easy to understand for non-programmers. This problem highlights one of the main requirements when working in developing games - that is - the need for collaboration. At this point I would like to profoundly thank Ryan Walker and my brother Russell Hewitt. Without their input, patience and hard work, I could not have achieved the design and implementation of the various core strategies essential to this project.

Adding interactivity

Before looking at implementing video strategies arriving out of the SOLO Taxonomy a basic way of interacting in this world needed to be created.

One of the features of Unity, is the ease of dropping and dragging existing scripts into the game world. One such pre-existing script is the “first person controller” script. It provides a camera through which the player sees the world, and can be moved by the standard computer input keys of w, a, s and d. Once the terrain has a mesh collider attached to it, the first-person controller can move in any direction upon that surface in the same manner as a person would perceive a scene and move around accordingly constrained only by their field of vision. For instance, limits can be set on angles to climb, the scale of the controller and the field of vision of the camera.
In order to interact with objects a method of letting players know that they could interact with an object needed to be devised. Due to computer system requirements it is simply not feasible to put an interaction onto every object that in the real world would logically possess some form of operation. So I drew upon the “Call of Duty 2” system where what is immediately in front of you will change colour if there is interactivity attached to it. This appeared to provide the simplest visual clue while keeping the screen real estate clutter free. There was some discussion amongst friends, as to whether there should be a “sight” of some sort to distinguish the centre of the screen. In the end I decided against this as it seemed to much like the traditional “shoot em up” game. A more context sensitive approach was preferred where items will appear on the graphic user interface (GUI) only when they are needed. This approach required significant testing. Eventually it was achieved through a system called “ray-casting” The computer throws out an imaginary ray, in much the same way as light emits from a torch. If the ray hits a collider, information is returned to the computer about what the object is, and if there is any event or action attached to it. This happens many times per second and allows a significant range of actions to take place.

A simple system of picking up objects and interacting with information was needed next. These operations were separated out depending on the type of information or object required. These standard abilities were required:

- picking up a single paged document
- being able to turn a document over
- putting a document down in the same location
- picking up an object and rotating it (e.g. a bully beef tin)
- picking up a diary,
- being able to turn a books pages either forwards or backwards
- being able to write in a journal
- have the the players writings in a journal recorded for assessment
- the ability to trigger audio
- the ability to trigger cinematics

Without going into the development of each script that enable these operations to take place except to say, that these scripts all had to be written, tested, rewritten and tested again and again. It is a process that takes some time to accomplish - however once done, these scripts can be used and refined for other games and simulations.

Picking up a single paged document

Once again much testing was involved which led to many discoveries. For instance it was learnt that for the script to work in Unity, the 3D mesh had to be created in Maya facing the z-plane. What might seem trivial information is actually very useful information. Many of these tips and tricks are probably well known to commercial game developers that are the result of skills and experience and tend to be seen as a developers commercial advantage.
The core mechanics of this script is quite simple. Once again, it relies on a ray-cast emanating from the camera and returning with information about a collision event. If the ray-cast returned positive a material was swapped on the object mesh. When the ray-cast was no longer colliding, the material swapped back to the original. This created the “highlight” effect on the object. Various attributes were added, such as a flip feature, a scrollable feature, a rotation feature, and a face down feature. All these factors were added into the script to make it more versatile. The computer also needed to know the quaternion angle of the players camera and what distance to display the object from the camera - so even the simple scripts become more difficult than one might think. This script is still not to a commercial standards and requires more work to iron out some “bugs”.

To demonstrate the proficiency in programming required, the “Handle Object” script is given in the Appendix in its entirety. This script represents hours of programming time and I guess the point that I am making here is that developing video games is a complex process requiring many skill sets. The complexity of developing educational video games is even greater and more diverse.

Picking up a diary

A benefit of choosing the Gallipoli story as subject matter for the game is the large number of resources available containing information. There are quite a few personalised accounts of events, full of poignant memories. These accounts can be found in compilations like “Voices from Gallipoli” (Shadbolt, 1988) or in individual memoirs like “ANZAC - A Retrospect” (Malthus, 2002).

As part of the environment it was conceived that students should be able to move around and explore Anzac Cove freely. If enough richness of detail was provided to interact with, students could find themselves reading and exploring multiple personal histories. One obvious method to do this was through the vehicle of the soldier’s diary.

The requirement was a diary that could be located, picked up, the pages turned, and then put back down and frequently referred to. In order to achieve the ray-cast method was adopted to detect the interactivity on the book, which then called a script to display a GUI. Instead of the book being displayed a certain distance from the camera, the pages needed to full the screen and be readable. This would ensure maximum resolution and optimum lighting.

Sections of various journals were transcribed into Microsoft Word, and then copied and pasted into Photoshop. The creation of an individual look for each page was devised giving them a weathered and an individual appearance. However in transcribing these passages and although using small extracts for educational research use, permission from publishers would be needed for a commercial edition - no doubt incurring a royalty fee.

Figure 10: A screen shot of Percival Fenwick’s diary. Each page has been individually crafted. Students found it difficult to read the cursive script.
Ideally all the pages would be animated as they turned - this is possible - but the more cost effective method of simply toggling through images of pages was eventually settled upon.

Audio was added of the dialogue being read, providing a “personality” and a personal voice to each story. Audio sounds of pages turning were also added.

Writing in a journal

One important feature included was the ability for student players to record their thought and feelings as they experienced certain events. This capability is fundamental to an educational game, as it provides a mechanism to record data set for assessment purposes. Integrated assessment must be considered as essential within an educational video game and should be both integral and fundamental to design. Student thinking during game play is implicit and requires specific strategies to draw out critical thinking. The classroom teacher cannot be expected to monitor these complex interactions and decision making across multiple students - so it is incumbent on the developers to design products with relevant and appropriate assessment systems.

When thinking about the journal the realisation came that an external database was a prerequisite. Both teachers and students would need to log in to a secure web-site before playing the game. This way student information can be tracked and retrieved. When writing in the journal, every time a student hits the return key or closes the journal the information is automatically sent to this internet database. When you open the journal again, the information should still be available.

This system allows reports to be written and sent as part of the game objectives.

Technical issues arose when looking at method used to type and edit the journal. One such issue was screen resolution and text placement - when the game view screen is reduced the text often flows out of the border of the journal. Upon investigation, it was found that this is indeed the case with many computer games. It is untidy and not satisfactory but would need significant development time to resolve the script.

For the purposes of this research the script that was written is perfectly adequate.

The inventory system.

The inventory system was considered to be fundamental to the “Gallipoli Experience”. As mentioned above the inventory allows players choice - and meaningful choices allow students to hypothesis and try out ideas.

The general premise is that the player can approach an object, and providing the game design allows, have the choice of selecting and adding the object into their inventory. This is simply a game abstraction for having the ability to carry objects from one location to another.

Once again clear logic and considerable scripting are required to achieve this end. A very simple scroll system where each object picked up is added to the game database, can be called via keyboard control, toggled and selected, was settled upon.
It is envisaged that for the finished game a system will be developed whereby every useable object has two values attached to it: volume and weight. Volume and weight are described through mathematical values. A stretcher might have a volume rating of 12 out of 20 and a weight rating of 6 out of 20, whereas a first field dressing might have a value of 1/20 for volume and 1/20 for weight. The player has a maximum value for each that cannot be exceeded. If a player chooses two large heavy objects they will be required to make a decision about which object to take and which object to leave behind. This has the potential to not only make game play very interesting, but also diversify the types of experiences each student might have in the classroom.
A & B: A photographic reference is used to create 3 digital images. These are “baked” from projections cast onto the surface of the face mesh. They are then combined in Photoshop to create the final face texture, with the correct UV layout.

C: The final UV layout for the soldier

D: An illustration showing the soldier mesh, smooth shaded mesh and the final look. The figure is in the traditional “T” pose. This makes it easier for adding animation controls.

E: A close up of the face, showing a low polygon mesh with a highly detailed texture map.
Devising an ANZAC SOLO Taxonomy “testlet”

Once New Zealand’s involvement in the Gallipoli campaign was decided upon, the specific learning context required some decision making. In order to do this, I created a chart that took the six major processes involved in understanding history that Biggs and Collis identified (Biggs and Collis, 1984), and posed a question relating to the Gallipoli experience at each level of the SOLO Taxonomy. I made a conscious decision to work with these processes, rather than identifying strands directly relevant to history in the draft New Zealand curriculum document, as the six Biggs and Collis processes had been used successfully to demonstrate each level of the SOLO taxonomy in assessment.

<table>
<thead>
<tr>
<th>Unistructural</th>
<th>Drawing conclusions from a display of information</th>
<th>What is Quinns Post?</th>
<th>How many New Zealanders served at Gallipoli?</th>
<th>What major battle did New Zealand soldiers fight during August 1915?</th>
<th>What was the main objective of the Dardenelles plan?</th>
<th>From which country were the majority of allied officers drawn?</th>
<th>In which country is the Gallipoli peninsular?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multistructural</td>
<td>Making value judgments about an historic event</td>
<td>How many ANZAC troops were killed at Gallipoli?</td>
<td>List two strategic objectives of the August offensive</td>
<td>What defenses did the Turks have in place to defend the narrows?</td>
<td>Name the social classes prevalent in English society in 1915</td>
<td>Which two countries landed soldiers near Gaba Tepe in April of 1915?</td>
<td></td>
</tr>
<tr>
<td>Relational</td>
<td></td>
<td></td>
<td></td>
<td>What factors contributed to the defeat at Chunuk Bair?</td>
<td>Why was the Fleet unable to force the “Narrows”?</td>
<td>Why were the majority of allied officers drawn from the English upper class?</td>
<td>Explain the relationship between the conditions found at Gallipoli and the attrition rate of Anzac soldiers.</td>
</tr>
<tr>
<td>Extended Abstract</td>
<td></td>
<td></td>
<td></td>
<td>Whose responsibility was the defeat at Chunuk Bair? Why do you think that?</td>
<td>What would have been the probable consequences if the Navy had breached “The Narrows”?</td>
<td>What traits distinguished New Zealand and Australian soldiers apart from their English counterparts?</td>
<td>Describe the significance of the term “ANZAC”</td>
</tr>
</tbody>
</table>

From these questions grew the lists of digital assets and strategies that would be required inside a video game in order to provide enough evidence / experiences for the student players to answer. For the purposes of this research I have taken the process of “Inducing meaning of a concept from a context.”

It should be noted though, that one of the reasons the Gallipoli story was chosen was for its importance to New Zealand, and its relevance to the New Zealand Curriculum. New Zealand's involvement in
war, and its effect, is taught at secondary school within the social sciences learning area and the history curriculum.

The New Zealand Social Studies Curriculum (Ministry of Education, 2007) identifies four conceptual strands: Identity, Culture, and Organisation; Place and Environment; Continuity and Change and Economic World, as well as five key competencies: managing self, relating to others, using language, symbols and texts, participating and contributing and thinking. Under the heading of “Continuity and Change” it states:

*Students learn about past events, experiences, and actions and the changing ways in which these have been interpreted over time. This helps them to understand the past and the present and to imagine possible futures.*

It continues:

*Students will gain knowledge, skills, and experience to:*

- Understand that the causes, consequences, and explanations of historical events that are of significance to New Zealanders are complex and how and why they are contested.

- Understand how trends over time reflect social, economic, and political forces.

For an untrained eye it seems that the events at Gallipoli fit well into the intent of the new curriculum document and will continue to be an important episode of history related to young New Zealanders.

Currently events at Gallipoli can be addressed under numerous National Certificate in Educational Achievement standards. One such example is AS90468, a level 2 Achievement Standard: Examine perspectives and responses of, and demonstrate empathy for, people in an historical setting (New Zealand Qualifications Authority, 2005). Achievement with excellence requires the following criteria to be met:

- **Comprehensively and convincingly describe and explain perspectives and responses of people in an historical setting**

- **Consistently demonstrate empathy with people in an historical setting, in an imaginative manner and with authenticity to the time period.**

The following explanatory note caught my eye:

This achievement standard is fine tuned to relate to the major aims and objectives identified by History, Forms 5 to 7: Syllabus for Schools, (Learning Media, Ministry of Education, 1989) in particular, the aim that states “to develop in students the ability to enter imaginatively into the events of the past.”

There is a vast potential for video games to do just this - to allow students to enter into the past and gain a unique perspective on events. Students demonstrating “…empathy with people in an historical setting, in an imaginative manner and with authenticity to the time period…” should not be a problem!

Being aware of the national assessment requirements is important when thinking about digital based games design in education. With a curriculum that is often claimed to be “over full”, classroom teachers are more likely to use resources that are already geared for assessment and deliver “credits” to learners. These are pragmatic considerations, but are core to the success of any digital based game resource.
Unistructural and Multistructural game strategies

Unistructural and Multistructural game strategies are not difficult to find and implement in a historical based video games. When talking to parents about the potential for video games in education, several have commented about their children’s capacity to absorb details from their favourite game - for instance knowledge of World War II weapon types, ammunition rate and effectiveness over what range.

The challenge is to build similar capacity within game structures that allow similar recall patterns. The unistructural level must provide the building blocks from which to draw out “deep learning”, and so it is essential that strategies at this level of the taxonomy are effective.

What quickly became apparent was that there was no one strategy that would suffice, but instead a careful layering of detail and content was required.

To enable this the process I used was the following:

A list was created with the key knowledge that by the end of the game students would be expected to know about the Gallipoli campaign. The information gathered for this was gleaned from both New Zealand and Australian teaching resources available online. The list was then broken down into smaller logical parts, and distributed across multiple game levels.

For each of the levels, in-game strategies were devised that would relay the information. Below is a sample of Level One and Two Key facts and in-game strategies.

<table>
<thead>
<tr>
<th>KNOWLEDGE</th>
<th>IN-GAME STRATEGIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The location of Turkey</td>
<td>- Map</td>
</tr>
<tr>
<td></td>
<td>- opening cinematic</td>
</tr>
<tr>
<td>• The location of Gallipoli</td>
<td>- Loading screen</td>
</tr>
<tr>
<td></td>
<td>- Map</td>
</tr>
<tr>
<td></td>
<td>- NPC conversations</td>
</tr>
<tr>
<td>• ANZAC acronym (Australia New Zealand Army Corps)</td>
<td>- On outside of folder</td>
</tr>
<tr>
<td></td>
<td>- insignias</td>
</tr>
<tr>
<td></td>
<td>- Signage of equipment</td>
</tr>
<tr>
<td></td>
<td>- NPC conversations</td>
</tr>
<tr>
<td>• The major powers involved in the conflict (Britain, France, Russia, British Commonwealth)</td>
<td>- Map</td>
</tr>
<tr>
<td></td>
<td>- opening cinematic</td>
</tr>
<tr>
<td></td>
<td>- flags</td>
</tr>
<tr>
<td></td>
<td>- uniforms</td>
</tr>
<tr>
<td></td>
<td>- signage</td>
</tr>
<tr>
<td>• The aim of the campaign (Open a second front, knock Turkey out of the war, open access by sea to Russia)</td>
<td>- Intelligence reports</td>
</tr>
<tr>
<td>• The failure of the Navy to force the Dardanelles</td>
<td>- NPC conversations</td>
</tr>
<tr>
<td></td>
<td>- newspaper reports</td>
</tr>
<tr>
<td>KNOWLEDGE</td>
<td>IN-GAME STRATEGIES</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------</td>
</tr>
<tr>
<td>• Seizure of the Dardenelles by the army the only way to capture the forts guarding the straits</td>
<td>- Intelligence briefing at HQ (Cut sequence)</td>
</tr>
<tr>
<td>• Who the commander of the Allied forces was (Sir Ian Hamilton)</td>
<td>- photograph at ANZAC HQ -written orders -NPC conversations</td>
</tr>
<tr>
<td>• Who the commander of the Turkish Army was (General Otto Von Liber-mann)</td>
<td>Intelligence Report (Dossier)</td>
</tr>
<tr>
<td>• Who the divisional commander of the Turkish forces was (Kemal At-taturk)</td>
<td>Intelligence Report</td>
</tr>
<tr>
<td>• Birdwoods speech prior to landing</td>
<td>-Journal entry</td>
</tr>
<tr>
<td>• The landing had not gone to plan</td>
<td>NPC conversations</td>
</tr>
<tr>
<td>• Medical supplies in short supply</td>
<td>Written request at HQ -limited physical resource (needed during game-play) -NPC conversations</td>
</tr>
<tr>
<td>• Numerous landings took place on April 25th</td>
<td>-map -intelligence Briefing at HQ -newspaper reports</td>
</tr>
<tr>
<td>• Location of Quinn’s Post</td>
<td>Map -NPC conversations</td>
</tr>
<tr>
<td>• Soldier experiences</td>
<td>Diary entry - Jack Dunn, Percival Fenwick</td>
</tr>
</tbody>
</table>

In some cases strategies are designed to “captivate” the player or funnel them through pre-set information they must observe. Loading screens are one such example, where all players are required to view this screen every time a new level plays. This is a common game design approach used to cover the time to load game assets into the computer ready for playing. It is so common that many players have come to expect that the graphics and audio played at these times will provide necessary background information to complete the level. Another occurrence of this is the “cut scene” where upon reaching a certain objective an in-game movie will play. This provides the discrete opportunity for other assets to be loaded, as well as develop characters, provide necessary information and generally drive the narrative forward.

Information needs to be explicitly tied to objectives. Unnecessary information is simply frustrating for players to have to wade through and diminished the playing experience.
Relational game strategies

Relational video game strategies require some thought regarding exactly what is required to help students “connect” ideas and concepts together, during game play.

The range of concepts students were required to induce and explain the relationship between the conditions found at Gallipoli and the attrition rate of ANZAC soldiers. All of these conditions, once found were then reconstituted in a second mind map, each being loosely associated with a more general concept.

An example of this is the soldiers exposure to constant fire was a direct result of the Allies being confined to a difficult terrain and a small area. Thus the general title of “environment.”

These concepts however can then be linked to each other to provide a deep understanding of causes. For instance, the confinement of Allied troops to the relatively small area (environment) could be considered the result of poor co-ordination shown at crucial moments - the more general concept being “Command organisation.”

But how to show these concepts and links in the video game itself? and more importantly, how do you make the relationships between these concepts explicit?

The concept of health was an easy choice. Health abstractions in video games are very common, and seemed a natural way forward.
The destructive power of machine guns became a reality in the first world war. In theatres such as the Gallipoli campaign, the response to this new weapon was woefully lacking. Commanders on the ground had little idea how to nullify the effect and continued to use old tactics with ever increasing numbers of number of troops to break the lines. This of course, added to the large casualty figures.

Student players could be made aware of this concept by witnessing the destructive power of machine guns first hand when visiting Quinn’s Post in Level Two. The issue here though, is how do you deal with the need for the threat of death during game play, but the need to keep the player alive and thus learning. One possible method to achieve this is through the use of “cut” sequences or in-game cinematics. These have been used traditionally during games where new information needs to be provided to the player, as well as to provide down time whilst the computer loads more digital assets.

Flies as carriers of disease

To provide students with concepts they could deduce from game-play required multiple strategies. One strategy that was devised and tested with students involved the familiar game abstraction of the health system. It was based on the concept of flies as carriers of disease.

Dysentery was a very real problem at Gallipoli. Along the front lines in no mans land corpses were unable to be reached without further injury and death, and so had to be left exposed to the elements. Flies moved from the bodies of the dead to the food of the living. Dysentery became one of the major factors in soldiers leaving the front-lines for the hospital ships and tents at Lemnos. As one soldier, (Waite, 1921) wrote:

Countless hordes of flies settled on everything edible. The soldiers waved them off. The black cloud rose and descended among the filth on the other side of the parapet. Presently they were back again on the food, and so on, from the jam to the corpse, and back again to the jam, flitted the insect swarm, ensuring that the germs of most things undesirable were conveyed to the soldier’s system through his mouth. -Fred Waite,

To illustrate this concept a simple health system was instituted. Each player started the game with a health of “20”. This was displayed on screen in simple text format. This appeared more appropriate to the time period than the common health bar system.

Players were required to find a food and water source to replenish their hunger and thirst. As the players went up to the fresh water barrel a collision event occurred, sending a message to the players inventory asking if there was a canteen loaded. If not, no action would occur and players would need to find
the canteen. If players had the canteen in their inventory an on screen prompt appeared asking if the player would like a drink? Yes or No. Upon

A similar process was used for the food. An opened can of food was available in one of the officers tents at Godley Terrace. To illustrate a can of cat food was photographed to show what the “Bully Beef” would have looked like after it had been sitting in the sun in stores for weeks. A sprite system of moving cards on which were displayed flies was subsequently constructed and loaded together with the sound of flies buzzing. When the

Improvements on this system would involve scripts that allow players health to initially rise, then fall over time.

An obvious method of providing information from which students can draw out links between concepts is by providing authentic extracts for student players to read. The following extract (Harper, 2001) provides some clues as to the link between the terrain and the high casualty rate:

“Our landing place is a small bay on the west coast of the peninsular just above The Narrows. The beach is good, but the hills rise immediately from the beach to a height in the highest point on our left of about 600 feet. Steep gullies and ravine are in the face of these hills and they are covered with a thick low scrub...

... The casualties on our side were heavy, but that can only be expected under the circumstances - landing against such odds and immediate rising country was a great credit to New Zealanders and Australians as the warships could only cover them by pounding away, they could not locate every battery they had as they were so wonderfully concealed.

By midday, when the Turks were driven back, we took the ridge and four Krupp guns and some machine guns. A great number of our men were injured by falls while scaling the hillside gullies. When the Turks were driven back the Australians chased them, but sufficient troops were not yet landed to go so far on. Consequently they had to drop back a little in the afternoon. However they had cleared the face of the hill for a good distance. Snipers were all over the hillside and picked off the officers galore, many being shot dead and some seriously wounded... - Lieutenant Fred McKee of the 2nd Canterbury Battalion

This method is simply repurposing of a traditional method that is used to transmit knowledge.

One of the challenges in using 3D games to foster higher order thinking is ensuring that the thinking does not remain in the students head, that is, remain implicit knowledge, but rather, can be made explicit and available for teachers to assess. Strategies to reinforce concepts need to be in place to help the implicit knowledge gained during gameplay become explicit. An example might be upon demise of the players health points an onscreen message appears detailing what has happened and the reasons why.
Extended abstract game strategies

Strategies used in video games to encourage students to think at the extended abstract level require a different approach to those at the Relational level. As students work in the extended abstract level of the SOLO taxonomy, they are asked to perceive a general or guiding principle from the relational level and apply it to contexts outside of their experience. Extended abstract thinking thus requires carefully considered game based tasks and learning contexts from which a principle can be deduced and successfully applied to a second set task within game play. These tasks may be either in a different area of the same level or across multiple levels. This process of deducing principles and applying them to another context reflects Gee’s “Probing Principle” (Gee, 2003) where “learning is a cycle of probing the world (doing something); reflecting in and on this action and, on this basis, forming a hypothesis; re-probing the world to test this hypothesis; and then accepting or rethinking this hypothesis. (p. 107)

One task might be to consider why the machine guns have been positioned to face almost parallel to no mans land instead of facing directly towards the enemy. This knowledge could then be utilised during another level of the game. Deductions could be drawn from observation of a fire fight, comments from NPC’s and access to maps. Wider implications of the machine gun’s destructive power and its impact on tactics in the first world war could then be discussed.

Care has to be taken when asking extended abstract questions. Questions need to match the learning context provided.

For instance an inherent problem arises when after taking on the identity of a person who witnessed the birth of the legend of ANZAC, being asked to explain the “significance” of the term “ANZAC” today. This presents and inherent problem - that is, this not only involves the student player divesting themselves of their assumed identity and thus breaking immersion, but also of taking on the role of another identity, (that of contemporary student researcher) and working with a new knowledge set not available to their in-game identity. That is, an individual who lives and breaths at Gallipoli in 1915, being asked to comment on the significance of ANZAC in 2007. This of course creates conflict in the student. They are being asked to perform tasks that are incongruous with their assumed identity. In order for students to move successfully from one identity to another, there should be a compelling and transparent reason to do so. The student needs to be acutely aware of this transition.

Tagged Object Resources

To overcome this issue it was necessary to develop the “Tagged Object Resource”. A Tagged Object Resource (TOR) is an in game object that has been assigned research information. An example of this from “The Gallipoli Experience” is when a player walks up from Watson's Pier towards Godley Terrace, they must pass a series of burial sites. If players choose to examine the crosses, two things occur. First a simple
sentence appears detailing information. “2876 New Zealand soldiers died during the Gallipoli campaign”. The second is the cross turns red - signifying that further research information is available. The student then has the option of “tagging” the object for further research, or continuing with the game. Upon completion of the game, students log-in to the “Gallipoli Experience” web-site and are presented with a detailed list of information and quotes, based on the resources they “tagged” whilst playing the game. These quotes can be reordered by the student or deleted if desired, when seen against the extended abstract question posed by the teacher. Students are then able to either print out their research, or compose their essay answers directly into the web-site.

The advantages of a system like this is that immersion is maintained, and yet students are able to gather information and resources during game-play that can be accessed from an external web-site and then used in the classroom at will.

This ability to return to data collected during game play could have several benefits for the implementation of the game into the classroom setting.

Diana Oblinger (Oblinger, 2006) comments:

*Beyond selection of a game, educators must consider when and how to integrate a game into the curriculum or the class. Options include use as a*

*preinstructional strategy,*

*coinstructional strategy (augmenting, illustrating, discussing), and*

*postinstructional strategy (for assessment and synthesis)*

The preinstructional strategy is where the teacher briefs students about the events at Gallipoli so that prior knowledge before playing the game is high. Co-instructional is where the teacher, whilst the game is being played, augments information, elicits discussion and actively guides students through the playing experience. The post instructional strategy is where the teacher provides an environment for post game reflection, discussion, and assessment.

The existence of a companion web-site with the “TOR” system promotes post instructional teaching as a viable method of teaching as resources and data is generated through game play. As each players experiences differ, discussions are possible to present and share the variety of information gathered. This does place an onus on teachers to be thoroughly conversant with the game and the questions it may raise.

Unfortunately a functioning web-site was not developed to fully test the mechanics of collating information from the “TOR” system. However this process post game play essentially follows methods traditionally taught in schools with respect to the research process.

Although implementation issues are beyond the scope of this project there are several key areas that need to be addressed. These include the availability of computers with appropriate graphic and sound cards as well as the provision of technical and game-play support.
Student Responses to developed game strategies

Individual strategies with a group of students were tested over several months. The group consisted of youths ranging in age from 12 to 19. There were a mixture of boys and girls - 8 boys and 4 girls. They were from several Christchurch secondary schools and had mixed video game player experience. Several students professed to not play video games at all.

Student Responses to Unistructural Game Strategies

What became interesting to me, with the Unistructural strategies was that the assumptions I made as a developer were not always born out. A case in point was where considerable time was spent developing a diary mechanism within the game where students could “discover” stories of the soldiers who were really there. The libraries are full of such resources, and in an endeavour to be authentic the text was written in Microsoft Word and then copied and pasted it into Adobe Photoshop, transforming the font into a cursive script. Particular care was taken to obtain a handsome looking script that had a hand-written feel and was entirely within keeping of a period diary - and then dutifully transcribed several days observations of Percival Fenwiks experiences, from his book “A Gallipoli Diary” (Fenwick, 2000). In the end I was pleased with the graphic effort, with each page of the diary being unique and whilst still rudimentary in terms of game engine techniques, it served (I thought) the purpose very well.

Comments back from students were unanimous in the fact the they all found cursive script very difficult to read. They had simply not been exposed to the need to read cursive script before, and in the context of a video game found the need to do so frustrating. Compounding this, was the amount of text - I had transcribed several pages in one go - and this proved too much written information to be delivered at one time to players - they were all eager to move and explore the environment - to interact with game elements.

To test to see if unistructural strategies were working a simple test was devised taking the form of a set of listed questions. Students simply engaged with the prototype game and answered questions on a separate piece of paper as they came across them.

The questions were:

In what country is Anzac Cove located?

When was a plan devised to capture the Gallipoli Peninsula?

Did British Military Intelligence considered it possible to launch a surprise attack on the Gallipoli Peninsula?

Who commanded the Ottoman 19th Division?

Who was the commander of the British Expedition?

All answers to the five questions were eventually found by all students, but it was interesting to see students making assumptions about where to find knowledge in a video game. One of the questions was, “In what country is the Gallipoli Peninsula”. Students immediately went to Headquarters and started picking up and reading files. They put them down when no answer could be found and then moved onto the next file. It took some time for students to realise that the information was provided not in written form, but was to be found on the large (although possibly obvious) map that was located beside all the docu-
ments they had been searching through. They all groaned when they realised and one student made the observation: “In the video games we play, we always need to pick up documents to find this sort of information.”

This was a salient lesson to me, that many students will impose their previous playing habits onto any educational video game, and will judge the educational game based on how easy these skills are transferred. The implications for this in developing a video game are quite profound and far reaching.

A further example of this transfer of playing expectations became apparent when a health kit was added into the scene. This came in the form of a box consisting of medical supplies. The idea was that players would have the choice of grabbing some medical supplies and putting them into their kit before moving on to Quinn’s Post. They would find out in the next level, that medical supplies were in demand at the front, and that their choice would have consequences in game play. The box was carefully constructed, textured, and animated to allow the lid to open. Inside the kit was modelled an authentic first field dressing from photographs I had taken from “The Waioru Army Museum.” This was placed inside with a script that upon player collision allowed the lid to open, and the field dressing to be examined.

And what did players do? The kept trying to run over the health kit, as if it was a “power up!”. “Power Ups” are objects that can be collected through the course of game play and provide an instant boost to the health level, sustaining a longer playing experience or simply put - staying alive longer. Once again, this is a learned strategy, common in video game genres. It is also an example of a game world abstraction that is far removed from the reality of the experience of war. It is a game world abstraction that I felt was entirely unsuited for this educational video game.

Student Responses to Multistructural Game Strategies

One expectation of students playing video games in the classroom is that on screen written information is kept to a minimum. In searching for answers to set questions, students stated that they would never read the amount of text I had included in the diary, unless forced to. This expectation of little written writing raises several questions, the first being, is there a difference between student expectations and teacher expectations. The answer is resoundingly yes! There is a significant divergence between the understandings and experience students bring to playing an educational game and that of teachers. Students have lived their lives imbibing games “culture” and have become adept at interpreting game world abstractions. Many teachers on the other hand have not, and feel suspicious of games in education as being yet another version of “The Emperors new clothes”.

There is also the tension between the needs and desires of teachers to impart knowledge, (both skills and content, combined with the pragmatic needs of school assessment systems) and the students experience of a game is. Most students do not associate video games and academic learning together.

The so called “edutainment” software of the ‘90’s has largely failed to make an impact upon school and learning. This has been put down to factors including the repetitive “drill and test” nature of many of the products and the strategy of marketing directly to students, whilst competing against pure entertainment software titles.

The American Federation of Scientists (2006) have recommended another strategy - marketing directly to schools and making the distinction between games for education and games for entertainment. By marketing directly to schools, both teacher and student preconceptions can be shaped. In the course of this
research, students have strongly indicated, that though they may not buy an educational title of the shelf, it is their preferred method of learning within the school system.

I am of the opinion that as both groups are exposed to effective educational games, divergent preconceptions and biases will narrow.

Student responses to Relational Game Strategies
Since health abstractions are common to 3D video games, the link between eating fly invested food with poor health was readily understood by all students. Five students commented that they were used to a “health bar” system, the remainder felt that the text method of display was “ok”. One of the most frequent comments was on the “annoying sound” of the flies. Several commented that it distracted them and they wished they could turn it off. A perceptive few made the comment that not being able to get rid of the flies provided a realism to the experience, and that they would not normally have appreciated such seemingly small details via other learning resource methods.

The shallow learning curve of an established game world abstraction like the health system reinforces the conviction of the need to thoroughly understand existing video games. We need not and should not be reinventing the wheel.

Student responses to Extended Abstract Game Strategies
Students liked the idea of being able to revisit the information they had collected during the game. This gave them a chance to “think” about details that during game time would have been dismissed as inconsequential to the task at hand.

The issue of the amount of text on screen was raised and one student commented:

“I don’t know if it is just me, but I won’t read it unless I absolutely had to - I am more interested in exploring...”

This response echoed the majority of student sentiment, and highlights the tension between the assumed role of the student and the student themselves whilst playing a game. Some of this tension can be eased through the use of TOR objects.

I am fully aware that these responses are not a conclusive example of the effectiveness of these chosen game development strategies illustrating the ability to encourage higher order thinking. Such an outcome would have required further resources, both in time and money, and the full completion of all game levels. It is my hope that this may still be accomplished and further testing take place. I do believe however that a methodology has been developed that has real potential to strengthen subsequent video game development and thereby ensure strategies are in place addressing critical thinking within video games. From experience and as opposed to the Bloom’s Taxonomy, the SOLO Taxonomy provides an easy to understand framework from which to develop educational video game strategies.

To clarify this process I revised the hypothetical model and produced the diagram: Workflow for devising educational material for inclusion in videogame design using the SOLO Taxonomy.

This process, I would suggest, provides a guiding methodology for identifying educational requirements to encourage higher order thinking, prior to the creation of the game overview design document. As for the strategies themselves, I have listed in Figure 15 some potential strategies that may be appropriate
for the type of genre represented by “The Gallipoli Experience”. Whilst some may be of use, strategies will need to be devised for each unique educational game.
Figure 15: The process identified to enable game developers to embed higher order thinking strategies in their game overview design document.
Where to from here?

Breadth of investment in research required

At the beginning of this report I highlighted some of the issues using “off the shelf” video games in the classroom were highlighted. While I strongly believe that there must be an urgent investment in the research and development of New Zealand specific titles, I also must advocate the exploration of the use of appropriate titles in the classroom.

International investment in educational games research at primary and secondary school level is increasing. Previously, research has been based in tertiary institutions, (for instance the Microsoft “Games to Teach” project at MIT).

In the last few months Learning and Teaching Scotland has established “The Consolarium”, the Scottish Centre for Games and Learning” whose web-site can be found at:

http://www.ltscotland.org.uk/ictineducation/gamesbasedlearning/index.asp

It is has been established by Learning and Teaching Scotland to explore the world of computer games and how they can impact on the teaching and learning process in Scottish schools. The web-site is in its infancy, but highlights sharing practice in both educational game development and “off the shelf” titles. It is well worth keeping an eye upon.

The potential of existing game consoles for educational teaching and learning

One of the criticisms of the major consoles available on the market is that the research and development they have undertaken has been directed to greater realism and graphics, coupled with processing power. This focus has been criticised as not growing the potential audience but instead being attractive to the pre existing customer.

Not so the Nintendo Wii (VG Charts, 2007) - the latest console on the block that includes motion controllers allowing a more physical aspect to the game. This courageous decision by Nintendo not to follow suit, but set out on its own path has paid off. As of August 23rd this year, the Nintendo Wii has become the market leader console, out selling the Microsoft 360 console and Sony Playstation 3. Nintendo was last market leader in 1994 when the Gameboy dominated markets.

The potential of the motion controllers in the Wii have intrigued me, particularly as it has been announced that the Unity 2 game engine will port to the Wii in the imminent future.

Recently I came across a review of a game available on the overseas market. It is called: “Trauma Centre: Second Opinion”. It is a port from a very successful game (Trauma Centre: Under the Knife) on the Nintendo DS, which uses a stylus, here replaced by the motion controllers. This is what Nintendo has to say about it (IGN Entertainment, 2007):

“*The Nintendo DS doctor sim now comes to the Wii console -- use the unique controller to save patients’ lives!*  
You play the surgeon in this exciting medical drama simulation. You’ll need to cure patients of everything from routine medical maladies to life-threatening designer viruses. And, of course, there’s all that drama waiting just outside of the operating room. Your medical toolkit includes scalpels, forceps, defibrillator paddles, syringes and more -- all designed for use with the Wii Remote!*"
From watching the teaser videos and video reviews it looks very entertaining and fun to play. Although it possesses many obvious game world abstractions, it highlights the potential for making medical simulations available to school students and the potential for engaged learning. Players are exposed to medical terminology, processes and tools, which they learn to wield while playing against time to save lives. It would be very interesting to see this game (and other like it) trialled in New Zealand school to measure its effectiveness as a learning tool.

The other game that I am keen to play is the new game “Spore” from the creator of the Sims, Will Wright. TED.com have a brief biography on him and under the heading “Why you should listen to him” Wright was described as (TED.com, 2007):

“A technical virtuoso with boundless imagination, Will Wright has created a style of computer gaming unlike any that came before, emphasising learning more than losing, invention more than sport. With his hit game SimCity, he spurred players to make predictions, take risks, and sometimes fail miserably, as they built their own virtual urban worlds. With his follow-up hit, “The Sims”, he encouraged the same creativity toward building a household, all the while preserving the addictive fun of ordinary video games. His next game, Spore, which he previewed at TED2007, evolves an entire universe from a single-celled creature.”

There is a very interesting video to be found at http://www.ted.com/index.php/talks/view/id/146. In it Will Wright talks of some of his learning experiences and how they have encouraged him to push the boundaries of video games, or as he calls them “toys”

Further research required in the classroom

New Zealand requires a functioning open-ended educational video game prototype to trial in the classroom. This must be developed based on sound educational principles. It is clear from existing studies that game implementation into the classroom is integral to the learning experience with video games. These integration issues require research in a New Zealand context.

As previously mentioned there are many issues that hinder the creation of such a game, but with vision and determination these need to be overcome if New Zealand students are to be engaged, motivated and find learning relevant.
Conclusions

I would concur with Simon Egenfeldt-Nielsen (Egenfeldy-Nielsen, 2007) when he wrote that developing educational games:

“...is probably among the hardest challenges in game development. In designing computer games for educational use, game developers run into a dangerous cocktail of problems on many levels that the game industry has only just begun to engage with on their own turf. When developing computer games for educational use, you are faced with the challenge of designing a computer game that should be engaging and challenging as a commercial computer game, but at the same time meets the requirements of lesson plans and curriculum while catering to very diverse target groups”.

Educational game development that goes beyond the training aspects of edutainment titles are complex, and to date, costly. Collaborative approaches within New Zealand are essential if their benefits are to be realised. More research is needed, with a co-ordinated approach across Tertiary, Secondary and Primary sectors to maximise resources and efficiency.

New Zealand must find the means to develop local and authentic content if it is to engage, motivate and provide relevant educational experiences for our youth.

On a personal note, I found it interesting that I started this project based very much on James Paul Gee’s theories (of which I am convinced) and hence a cognitivist approach, but have moved significantly to appreciate the relevance of the constructivist model in digital based games learning. This constructivist approach in games is often mini worlds in which a set topic is represented in different objects and artifacts that the player can interact with. Egenfeldt-Nielsen explains this (Egenfeldt-Nielsen, 2006):

“A microworld simulates a part of a world that is simplified and constructed to facilitate working with concrete objects. When interacting with objects in microworlds, we are learning about the object’s properties, connections and applications. The player can engage and manipulate these artifacts and thereby construct a perception of the given topic.” (p. 198)

An extension of this type of digital based game would be the massively multiplayer online game (MMO). The Horizon report (2007) describes their educational appeal:

“What makes these games especially compelling and effective is their multiplayer nature - students can work in small or large groups, or can pursue goals solo, all in the context of a larger community of player-learners. Role-playing is possible, but not essential component. Other possible interactions include mentoring of new players by more experienced ones, competitive team activities, and collaborative world-building”. (p. 25)

I find these aspects very exciting and the potential for education revolutionary. The report also suggests that mainstream adoption of these types of games by leading educational institutions are about four to five years away.

The New Zealand education system should continue to research and develop considered strategies that align with these emerging technologies.

In conclusion, through this project I have attempted to find a way forward for educational game developers to develop strategies that encourage higher order thinking. In my mind, there is no doubt that the traditional model of Bloom’s Taxonomy (Bloom, 1956) is unsuitable, whereas the SOLO Taxonomy (Biggs
and Collis, 1984) provides some promise. The benefit being it is accessible, flexible, is useful to develop content and assess.

The strategies I have developed as examples did not illustrate a fully functioning prototype - nor did it provide opportunities to fully test the integration of devised game play within a functioning classroom context. This must wait until the future, but it does provide a possible framework, based on a sound educational model, for pointing game developers towards a methodology to ensure higher order thinking strategies are embedded into game design.
Appendix: the “Handle Object” script

var cameraToFace : Camera;
var defaultMaterial : Material;
var selectMaterial : Material;
var flipable = false;
var scrollable = false;
var rotateable = false;
var faceDown = false;
var degrees = 10;
var scaleFactor = 1.0;

private var originPos : Vector3;
private var originRot : Quaternion;
private var originRotFlipped : Quaternion;

private var objectDistance : float;
private var pickedUp = false;
private var flipped = false;
private var audioPlayed = false;

function Start () {
    originPos = transform.position;
    originRot = transform.rotation;
    transform.Rotate(Vector3.up, 180);
    originRotFlipped = transform.rotation;
    if (faceDown) flipped = true; else transform.rotation = originRot;
}

function FreezeCharacter (freeze : boolean) {
    var player : GameObject;
    var script : MonoBehaviour;
    player = GameObject.Find("/First Person Controller");
    script = player.GetComponent("MouseLook");
    script.enabled = !freeze;
    script = player.GetComponent("FPSWalker");
    script.enabled = !freeze;
    player = GameObject.Find("/First Person Controller/Main Camera");
    script = player.GetComponent("MouseLook");
    script.enabled = !freeze;
}

function DistanceToPoint () {
    return (transform.localScale.y / 2) * Mathf.Tan((90 - (cameraToFace.fieldOfView / 2)) * Mathf.Deg2Rad);
}

function Adjust () {
    var ray : Ray;
    ray = Ray(cameraToFace.transform.position, cameraToFace.transform.forward);
    return ray.GetPoint(objectDistance);
}

function PlayAudio () {
    if (audio)
        if (audio.clip) {
            audio.Play();
            audioPlayed = true;
        }
}

function Update () {
    if (pickedUp) {

    }
}
if (!audioPlayed) PlayAudio();
if (!rotateable && !flipped) {
    transform.LookAt(transform.position + cameraToFace.transform.rotation * Vector3.back,
                   cameraToFace.transform.rotation * Vector3.up);
} else if (!rotateable && flipped) {
    transform.LookAt(transform.position + cameraToFace.transform.rotation * Vector3.forward,
                   cameraToFace.transform.rotation * Vector3.up);
}

private var rotated : int;

function ObjectAvailable (sighted : boolean) {
    if (sighted) {
        switch (pickedUp) {
            case false:
                if (renderer) renderer.sharedMaterial = selectMaterial;
                if (Input.GetKeyDown("p")) {
                    if (renderer) renderer.sharedMaterial = defaultMaterial;
                    FreezeCharacter(true);
                    transform.localScale = transform.localScale / scaleFactor;
                    objectDistance = DistanceToPoint();
                    transform.position = Adjust();
                    if (!flipped) {
                        transform.LookAt(transform.position + cameraToFace.transform.rotation * Vector3.back,
                                          cameraToFace.transform.rotation * Vector3.up);
                    } else {
                        transform.LookAt(transform.position + cameraToFace.transform.rotation * Vector3.forward,
                                          cameraToFace.transform.rotation * Vector3.up);
                    }
                }
                pickedUp = true;
                rotated = 0;
                break;
            case true:
                if (pickedUp && flipable && Input.GetKeyDown("f")) {
                    transform.Rotate(Vector3.up, 180);
                    flipped = !flipped;
                }
                if (pickedUp && scrollable && Input.GetKeyDown("o")) {
                    if (objectDistance > 0.25) {
                        objectDistance -= 0.1;
                        transform.Translate(0, 0, -0.1, cameraToFace.transform);
                    }
                }
                if (pickedUp && scrollable && Input.GetKeyDown("m")) {
                    if (objectDistance < DistanceToPoint()) {
                        objectDistance += 0.1;
                        transform.Translate(0, 0, 0.1, cameraToFace.transform);
                    }
                }
                if (pickedUp && scrollable && Input.GetKeyDown("i")) {
                    transform.Translate(0, 0.1, 0, cameraToFace.transform);
                }
                if (pickedUp && scrollable && Input.GetKeyDown("k")) {
                    transform.Translate(0, -0.1, 0, cameraToFace.transform);
                }
                if (Input.GetKeyDown("j")) {
                    if (pickedUp && scrollable) transform.Translate(-0.1, 0, 0, cameraToFace.transform);
                    else if (pickedUp && rotateable) {
                        transform.Rotate(Vector3.up, degrees);
                        rotated += degrees;
                        if (rotated > 90) {
                            rotated = 180;
                            flipped = !flipped;
                        }
                    }
                }
    }
}

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if (Input.GetKeyDown("l")) {
  if (pickedUp && scrollable) transform.Translate(0.1, 0, 0, cameraToFace.transform); 
  else
    if (pickedUp && rotateable) {
      transform.Rotate(Vector3.up, -degrees);
      rotated -= degrees;
      if (rotated < -90) {
        rotated += 180;
        flipped = !flipped;
      }
    }
}

if (Input.GetKeyDown("p")) {
  if (audio) {
    while (audio.isPlaying) {} 
    audioPlayed = false;
  }
  pickedUp = false;
  FreezeCharacter(false);
  if (renderer) renderer.sharedMaterial = selectMaterial;
  transform.localScale = transform.localScale * scaleFactor;
  transform.position = originPos;
  if (!flipped) transform.rotation = originRot; else transform.rotation = originRotFlipped;
}

if (!sighted) {
  if (renderer) renderer.sharedMaterial = defaultMaterial;
}
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