UNIVERSITY OF SOUTHAMPTON

# Towards Better Gameplay in Educational Computer Games: A PhD Thesis

by

Alex Frazer (ajf06r)

Supervisors: Dr. Gary Wills (gbw),

Dr. David Argles (da)

A thesis submitted in partial fulfillment for the degree of Doctor of Philosophy

in the

Faculty of Engineering, Science and Mathematics

School of Electronics and Computer Science

November 2010

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF ENGINEERING, SCIENCE AND MATHEMATICS
SCHOOL OF ELECTRONICS AND COMPUTER SCIENCE

Doctor of Philosophy

by Alex Frazer (ajf06r)
Supervisors: Dr. Gary Wills (gbw),
Dr. David Argles (da)

There is currently a notable amount of research suggesting that educators should use computer games as part of their teaching. Most of this research suggests *why* games should be used choosing very specific example games, or making broad sweeping statements about gaming as a whole. But very little of the research explains *how* these games should be used. What features should be present in the game? Do these features change depending on a given learning outcome? Do they change depending on the type of game? This thesis begins by compiling a prospective set of required features for an educational game, taken from literature on Learning Environments, as well as the requirements of different learning styles. This requirement set is cross-referenced with an overview of some typical, commercially available games, to show that such games are capable of meeting these requirements. This preliminary list is used in two investigations: the first explores how well the chosen features are offered by a series of current educational mini-games; the second shows how different requirements are offered by different commercially-available computer game genres. The results of these investigations are used to refine the list, before carrying out a user survey to identify the important features offered by different game genres, and to determine whether game quality improves as more of the features are met. The survey results show that some key requirements separate the genres significantly, while others were consistent across all genres. In addition, there is a positive correlation between each feature offered, and the overall user enjoyment of the game. The thesis concludes with a proposed framework of game genres and features, to assist in the design and selection of games for a given educational scenario, as well as some suggestions for future work.

# Contents

# List of Figures

# List of Tables

# Declaration of Authorship

I, ....., declare that the thesis entitled

.....

and the work presented in the thesis are both my own, and have been generated by me as the result of my own original research. I confirm that:

- this work was done wholly or mainly while in candidature for a research degree at this University;
- where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
- where I have consulted the published work of others, this is always clearly attributed;
- where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
- I have acknowledged all main sources of help;
- where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
- parts of this work have been published as:
  - Hooper, C. J., Frazer, A. and Prince, R. (2010) *Can educational games ever be fun? On redesigning the gaming experience.* In: Interface 2010, Warwick, UK.
  - Frazer, A., Argles, D. and Wills, G. (2008) *Demystifying the Educational Benefits of Different Gaming Genres.* In: ALT-C 2008: Rethinking the digital divide, 9-11 September 2008, Leeds, UK.
  - Frazer, A., Argles, D. and Wills, G. (2008) *The Same, But Different: The Educational Affordances of Different Gaming Genres.* In: ICALT 2008: The 8th IEEE International Conference on Advanced Learning, 1 to 5 July, Spain.

– Frazer, A., Argles, D. and Wills, G. (2007) *Assessing The Usefulness Of Mini-games As Educational Resources.* In: ALT-C 2007: Beyond Control, 4-6 September 2007, Nottingham, UK.

– Frazer, A., Argles, D. and Wills, G. (2007) *Is Less Actually More? The Usefulness Of Educational Mini-games.* In: The 7th IEEE International Conference on Advanced Learning Technologies, July 18-20, 2007, Niigata, Japan.

Signed: .....

Date: .....

# Acknowledgements

I would like to thank the following people, without whom this thesis would not have been possible:

My supervisors Dr. Gary Wills and Dr. David Argles, for their constant guidance, encouragement and enthusiasm.

My family, friends and colleagues, for putting up with my presence (and equally, my distance) for the past four years.

Charlie and Rikki (for their relentless workplace distractions), Sina, Jade and James (for "getting the band back together"), Darren (for the co-op), and the countless others I have ever had the pleasure of gaming with.

Additional thanks to Robert Florence and Ryan Macleod, for reminding me why I loved gaming in the first place, and to Will Cox for providing the lifetime of gaming memories on which my motivation this thesis was built.

# Chapter 1

# Introduction

The interest surrounding computer gaming in education has waxed and waned several times over recent years[1], with another rise on the horizon[2]. During this time, computer gaming has often been cited as an educational panacea, with values such as problem-solving, decision-making (Aguilera & Mendiz 2003), motivation (Facer 2002), real-time feedback and assistance (Fisch 2005), situated learning (Gee 2004*a*) and communal responsibility (Begg, Dewhurst & Ellaway 2004) promoted through gameplay. But how exactly do these values enhance the learning experience?

This thesis begins with a discussion on learning environments, and the desirable features for such an environment to have. As game spaces are inherently environments, with spaces governed by rules and entities exhibiting defined behaviours, it could be suggested that a game created for learning would itself be a learning environment. Therefore, existing papers on the requirements for a good learning environment are contrasted and compared, in order to generate a more robust requirement set. This set lists requirements for a good learning environment, and therefore it could be reasonably suggested, for a good educational game.

There follows a discussion of educational models and theories, identifying the key features which make them unique, as well as any features shared by different models which make them similar. Brief suggestions are then made as to how computer games, and in some cases computer gaming mechanisms, could be used to implement them successfully. This chapter exists to reinforce the idea that the affordances offered by games could be used successfully to support the learning styles associated with these different models.

[1] Since 2001, departments such as Stanford University's "Media X" workshop, MIT's "Education Arcade", Wisconsin-Madison's "Games, Learning and Society" program, and the Woodrow Wilson Center's "Serious Games Initiative" have all been established.

[2] As an example, the MacArthur Foundation pledged $50 million in 2007 to fund research into the educational use of games. In the same year, the UK "Serious Games Institute" was created, to research and develop Serious Games.

The set of requirements generated at this stage is used throughout the report as a means to analyse existing games – both individually and more generally – to identify successes and shortcomings in their ability to deliver an educational experience.

The first stage in this investigation looks into gameplay mechanisms in general. Examples are given, showing how different game-play mechanisms can be used to satisfy the different requirements established in the previous chapter. This acts as a starting point, helping to show that games made up of these mechanisms could satisfy the requirements, and that an attempt to develop a useful educational game would not necessarily be a futile one. A separate section of this chapter is given to gaming narrative, and examines how a rich narrative experience can help the learner to contextualise what they learn more successfully than an exercise without such depth.

A separate chapter is devoted to the evaluation of Massively Multiplayer Online Role-playing Games (MMORPG's). These games offer vast, persistent social worlds, populated by real human players to allow collaborative and competitive play across the Internet. Existing research and further discussion shows that the MMORPG genre caters for many of the requirements compiled in Chapter 2, with particular strengths in immersion, exploration, social interaction and provision of rewards. However, there are a number of potential pitfalls which come with MMORPG's, and these are discussed along with some solutions and workarounds to allow them to be used more successfully in a learning context. The popular online Multi-User Virtual World (MUVE) "Second Life" is then discussed, detailing the features which make it both highly suitable, yet also somewhat problematic when used in an educational manner.

Next, an investigation into minigames – short, self-contained games, usually based around a single principle, be it ludic or pedagogical. The complexity of using games to teach has been cited as a hindrance in their uptake (Becker & Jacobsen 2005), so these flexible, lightweight games could be just what today's educators are looking for. But are these mini-games really that useful in an educational context? Are they deep enough to illustrate the full pedagogical content of a given area? To explore these areas further, a number of minigames taken from the BBC Schools website are assessed against the set of requirements generated previously.

A second investigation into games is then presented, this time into the differences between gaming genres. Three games are taken from each of four different genres, and are examined against the set of learning environment requirements. By assessing which features are offered by the games in each genre, initial ideas can be formed on what type of learning models would be best supported by each type of game. It also serves to illustrate an important point: the concept of "games" in not especially useful when considering the breadth and depth of titles available today. By considering different genres appropriately, the community will stand in a stronger position when analysing, developing and implementing educational games.

This investigation is expanded into a much more in-depth survey of the affordances of different games from different genres. In this version of the experiment, the set of educational requirements is augmented and refined, and the set of games and genres is broadened. A questionnaire was offered to a set of expert users, to determine how well the different educational requirements are met by each game. The results were analysed to determine which features were offered most successfully by each different genre, as well as to determine whether support for each of the different educational requirements correlates with a more enjoyable gaming experience.

The thesis concludes with suggestions for future work, to build on the work conducted so far.

# Chapter 2

# Educational Background

A game space is inherently an environment – a self-contained area, governed by rules and containing entities which exhibit defined behaviours. As such, it could be reasonably suggested that a game created for learning would itself be a learning environment. In turn, it could be suggested that a set of requirements for a good educational environment could also be an appropriate set of requirements for a good educational game.

To explore this idea further, this chapter begins by discussing several papers, each focusing on learning theories specific to learning environments, or applying a more generic learning theory to the concept of these environments. The key points and requirements suggested by each paper are compared, and are finally compiled into a more comprehensive list of requirements for an educational environment. This list will be used throughout the thesis, to assess the suitability of some existing computer games when used as educational aids, and to help suggest which missing features could be added to make the games more appropriate.

The second part of the chapter presents a broader selection of educational theories, models and methodologies, along with some possible ways in which gaming could enhance their application. The selection is by no means exhaustive, but serves to highlight some of the more prominent educational theories, as well as to introduce the idea of how computer and video gaming could be used to implement them. The chapter concludes by relating the different learning styles back to the requirements gathered from the learning environments research. By considering the different styles in terms of how a learning environment might support them, we can begin to get an idea of how a learning *game* might support them.

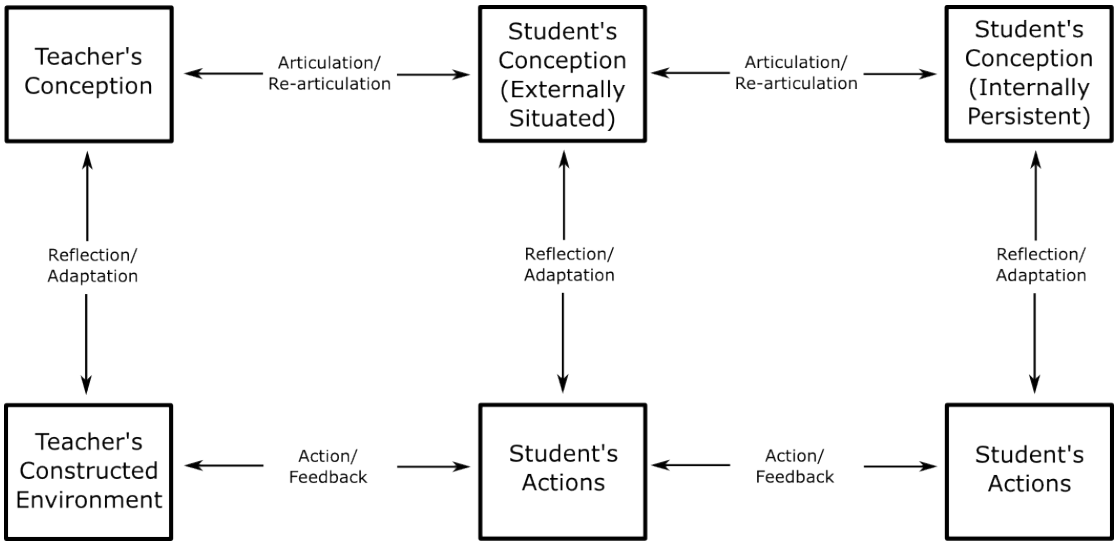


FIGURE 2.1: The "Conversational Framework" proposed by Laurillard (2002)

## 2.1 Learning Environments

For learning to take place effectively, a supporting environment should be established in order to convey new information in a meaningful way that can enhance the learner's view of the subject. To better understand how to arrive at such an environment, existing research is contrasted and compared, in order to identify the different authors' views on the key requirements.

### 2.1.1 Laurillard's "Conversational Framework"

Laurillard's "Conversational Framework" (Laurillard 2002) indicates several interactions which must take place for successful learning to occur. An instructor should create a theoretical model of a topic, and should help learners to create their own versions of this model through mutual, iterative articulation. Another key idea of the framework is that of an "experiential environment" allowing the learner to exercise goal-based behaviour. The learner reflects on their own conceptual understanding and adapts their behaviour in the experiential environment accordingly. Through a mixture of feedback both from the environment and the instructor, they will become more aware of how their own conceptualisation can be applied to a practical scenario. Similarly, the instructor can reflect on their own theoretical model and adapt the experiential environment in order to make it more useful to the learner.

The key points to take away from the framework are that:

- *instructor-learner interaction should be reciprocal* – this allows instructors to keep track of and feed back on learners' progress, and to update their own models and environments to improve the learning experience.

- *any theoretical or conceptual model must be exercised in a practical environment* – this gives contextual meaning to the model, allowing it to be successfully applied to future practical situations.

Laurillard also highlights a second conversation – one between the learner's "externally situated" and "internally persistent" selves (Laurillard 1999). It is important for the learner to integrate their conceptualisation of a more specific model with a more generalised, persistent one. In doing this, the learner improves their generalised model to include the more specific, newly acquired context-specific information. Without this internal conversation, new knowledge will only be applicable within a single context, with no potential to apply it to a more general set of scenarios.

### 2.1.2 Koper and Olivier

Koper and Olivier come up with their own set of requirements, suggesting that learning is becoming more "learner-centred, non- linear and self-directed" (Koper & Olivier 2004). This, in turn, suggests that traditional instruction is becoming less dominant in education, with emphasis now being placed on the learners developing knowledge on their own terms. This mirrors Laurillard's "Conversational Framework", focusing on learners exercising their conceptualisations in a practical environment and developing their internal models as a result. This learner-centric approach encourages learners to develop their internal models more strongly than in more traditional instructor- centric learning.

Some of the requirements proposed by Koper and Olivier include:

- *Integrate learner activities with instructor activities* – this improves the articulation between the conceptual models held by the learner and the instructor.
- *Bring more learning objects and resources together* – this allows each learning object to be seen in context, making it easier for learners to assimilate new specific knowledge with their existing persistent general knowledge.
- *Be customisable to different users' needs* – to be as useful as possible, a learning resource should be customisable based on users' existing knowledge and educational requirements. This allows more relevant information to be presented to the user, without boring them with existing knowledge or frustrating them with information that is too complex. This customisation should ideally be automated in real-time, making the learning experience as appropriate as possible at any given moment.
- *Be compatible with different standards* – a learning resource should be compatible with compliant environments, allowing it to be reused by multiple users without any further development.

#### 2.1.2.1 Merrill's "First Principles"

Koper and Olivier also draw attention to Merrill's "first principles of instruction" (Merrill 2004), which suggest learning is promoted when:

- *learners are engaged in solving real world problems* – exercising within a real-world scenario instantly gives contextual relevance to anything a student learns. Without such practical engagement, new knowledge remains theoretical, making it difficult to implement it in a practical environment.
- *existing knowledge is activated as the foundation for new knowledge* – analagous to the conversational framework, if a learner's existing persistent knowledge is used as the basis for new specific knowledge, the new knowledge is given long-term, contextual meaning.
- *new knowledge is demonstrated to the learner* – as shown in the "articulation/reartic-ulation" section of the Conversational Framework.
- *new knowledge is applied by the learner* – seen in the "action/feedback" section of the framework, where the learner acts within the experiential world established by the instructor.
- *new knowledge is integrated into the learner's world* – this applies to the entire right-hand side of the Conversational Framework, where the learner assimilates new specific knowledge into their own existing persistent representations.

### 2.1.3 Paras and Bizzocchi

Paras and Bizzocchi summarise the work of two other researchers – Norman and Keller – in order to present more helpful requirements for a learning environment.

#### 2.1.3.1 Norman's "Seven Basic Requirements"

The authors first highlight requirements in the form of Norman's "seven basic require-ments of a learning environment" (Paras & Bizzocchi 2005):

- *Provide a high intensity of interaction and feedback* – this is needed for the learner to successfully alter their actions based on progress within the environment. With-out feedback, the user might not notice any mistakes they are making; without sufficient interactivity, the environment will be unable to generate enough useful feedback with which to guide the user.

- *Have specific goals and established procedures* – goals are useful, as they provide learners with something to aim for. Without established procedures, the student may become frustrated in trying to determine the methods used by the system.
- *Motivate* – if the learner is motivated, they are more likely to drive themselves through the learning process without the need for external encouragement.
- *Provide a continual feeling of challenge that is neither so difficult as to create a sense of hopelessness and frustration, nor so easy as to produce boredom* – similar to Koper and Olivier's customisation requirement, this ensures the learning process targets the learner's exact needs and abilities, keeping them motivated by balancing between boredom and frustration.
- *Provide a sense of direct engagement, producing the feeling of directly experiencing the environment, directly working on the task; provide appropriate tools that fit the user and task so well that they aid and do not distract; avoid distractions and disruptions that intervene and destroy the subjective experience* – these three requirements all relate to promoting an immersive learning environment. By immersing themselves fully, the learner can absorb information from their own experiences, rather than from instruction. If the immersion is interrupted, the learner's experience will be less effective (Csikszentmihalyi 1997), making it important to use tools and techniques which maintain the immersion.

### 2.1.4 Keller's "ARCS" Method

The importance of motivation is further illustrated by referring to M. Keller's 'ARCS' method (Keller 1987):

- *"Attention strategies" for arousing and sustaining curiosity and interest* – if the environment generates curiosity, learners will be more motivated to explore by themselves.
- *"Relevance strategies" that link to learners' needs, interests, and motives* – when clearly-defined goals are linked to the learner's own learning interests, the learner becomes more motivated to pursue the goals, learning more about the subject as a result.
- *"Confidence strategies" that help students develop a positive expectation for successful achievement* – once again, the need to balance the learning experience is reinforced, with motivation arising from activities being neither tediously easy or frustratingly difficult.
- *"Satisfaction strategies" that provide extrinsic and intrinsic reinforcement for effort* – here, it is suggested that learners become more motivated to pursue a goal if achieving it will result in some kind of reward.

### 2.1.5 Compiling the Requirements

With all of these requirements in mind, we can now attempt to compile a single list of key requirements for an educational environment. By combining similar requirements discovered so far, a potential list is shown in Table 2.1.

One point of note, is that some of the requirements suggested by the authors relate to different areas of learning: Laurillard, for example, works in University-style lecturing, while Merrill's "First Principles" refer specifically to task-based learning. Keller's work also appears more relevant to hands-on, task based learning.

These differences are reflected in the compiled results. Merrill requires a demonstration of new knowledge, along with an environment in which to explore it directly, where Laurillard requires the opportunity for the instructor to create and affect this environment, and to have conversation with the learners within it.

However, the results also show some similarities between the different author's suggestions. Despite their differences, both Laurillard and Merrill require new knowledge in an explorable environment, along with the opportunity to contextualise the new information with what they already know. The combined provision both of clear goals, and the provocation of curiosity beyond these goals is suggested by Kellar and Norman. Laurillard, Norman, Koper and Olivier all state that conversation and the ability for instructors to provide feedback are key to a successful learning environment.

TABLE 2.1: A list of the requirements harvested from previous work, along with the papers they were taken from

| **Criterion** | **Laurillard** | **Koper & Olivier** | **Merrill** | **Paras & Bizzocchi** | |
|---|---|---|---|---|---|
| | | | | **Norman** | **Kellar** |
| Allow conversation between instructor and learner | X | X | | X | |
| Demonstrate new knowledge to the learner | X | | X | | |
| Allow instructors to establish experiential, explorable environments that are contextually relevant | X | | | | |
| Provide opportunity for learners to explore these worlds | X | X | X | X | |
| Allow instructors to provide feedback on the learners' actions | X | X | | X | |
| Provide a customisable balance between boredom and frustration | | X | | X | X |
| Provide the learner with explicit goals | | | | X | X |
| Allow the learner to integrate new information with their existing knowledge | X | X | X | | |
| Motivate the learner by provoking curiosity | | | | X | X |
| Promote a sense of immersion within the environment, free of distractions outside the environment's context | | | | X | |
| Offer rewards when goals are achieved successfully | | | | X | X |
| Unite a number of learning resources in a single environment | | X | | | |
| Support blended and full online learning | | X | | | |
| Allow the full pedagogical meaning of data to be expressed | | X | | | |
| Compatibility with different standards | | X | | | |

## 2.2 Educational Theories and Learning Styles

In addition to these requirements, it would also be useful to consider some established educational principles. By understanding gameplay affordances in relation to these principles, any future assessment of games will be more strongly grounded in educational theory, leading to more useful observations and analyses.

### 2.2.1 Constructivism

Constructivist learning supports the idea that people construct new knowledge by interacting with their environment (Bodner 1986). Everything the learner perceives is tested against their prior knowledge: if the perceived content is consistent within the learner's mental model of the world, it becomes new knowledge and is assimilated with what the learner already knows.

At a basic level, this is exactly what playing a game is. The player begins in a new "world" with a limited understanding of how anything within it works. Through "active experimentation" (Kiili & Ketamo 2007) and by interacting with their new environment, the player begins to understand more about the world, all within the context of what they already know.

In games with tightly-constraining rule sets, such as puzzle games, the player's experimentation may only extend as far as the different placement of coloured blocks, or differing strategies in using certain "special" blocks. In more open-ended games, such as the "sandbox"[1] title "Grand Theft Auto III", the player is free to explore seemingly endless combinations of weapons, equipment and environmental interactions in order to achieve their goals.

At both ends of the spectrum, the principle remains the same: the player explores and experiments within the bounds of the environment's rules, gradually adding new knowledge to their existing model wherever it is viable. The more they explore and interact, the more deeply the results are understood, and the more rich the player's knowledge becomes.

Constructivist learning also relies on the following principles:

- Knowledge is *physically constructed* during active learning
- Knowledge is *symbolically constructed* by creating representations of action

  When considering computer gaming as an activity, both of these learning types could fall under the same category, albeit on a sliding scale. Whilst the player may

[1] "A mode or option in otherwise goal oriented games" where "a player may turn off or ignore game objectives (Wikipedia)

not actually be carrying out the activity in real life, playing a sufficiently authentic simulation of the activity could offer sufficient affordances such that the activity is analogous to active learning. On the contrary, a game based around the same activity but with far less emphasis on accurate simulation would count as symbolic learning, with tokens and metaphors used instead of realistic replications.

As an example, the game "Full Spectrum Warrior" places the player in charge of a team of four U.S. Marines. The game is incredibly realistic in both appearance and behaviour, with troops behaving exactly as the would in accordance with the appropriate military regulations. Aside from the lack of genuine danger for the player, the orders they give and the feedback they receive is comparable to those found in real-life conflicts, making the game a fairly accurate simulation of small-scale troop deployment.

At the other end of the spectrum, we find "Advance Wars" – a turn-based tactical war game, involving rival armies and their units of vehicles and infantry. The units are represented with cartoon-style icons of soldiers, tanks, planes and ships, moving around a map divided into square spaces. When units meet in combat, their bonuses and penalties are compared, and casualties are removed from each side accordingly. On the surface, the game appears to be one of colourful toy soldiers, but on closer inspection, it becomes much deeper. A strict set of rules and statistics governs how well each unit behaves in combat, and many of these statistics bear some relevance to real life, e.g. anti-tank guns are strong against tanks, but weak against infantry; jeeps are quick and strong against unarmoured targets, but weak against anti-tank fire.

This example helps to show that whilst both activities involve computer games, the format in which they are presented and the affordances they offer can result in two different types of constructivist learning. With its realistic interactions and feedback, "Full Spectrum Warrior" could potentially be considered active learning, whilst the real-life metaphors hidden behind simplified tokens and interactions found in "Advance Wars", would probably place it in the symbolic learning category. In both cases, "learning by doing" enables the learner to understand more about the game world and the principles which govern it.

- Knowledge is *socially constructed* by conveying meaning to other learners

  This type of learning can most clearly be seen in Massively-Multiplayer Online RPG's (MMORPGs). Here, thousands of players occupy a single, persistent online world, with highly experienced players mingling with newcomers. Part of the genre's culture involves more experienced players teaching new players how to play the game, helping them to overcome the initial sections more quickly. In this way, knowledge about the game world is constructed socially, with more and more players learning how the game works as a result of the communal knowledge found within the game world itself.

This type of learning (and indeed, play) is expressed in the concept of the "Zone of Proximal Development" (ZPD), coined by Vygotsky. The ZPD expresses the difference between the knowledge and ability that a child already possesses, and the potential abilities which they can only realise by interaction with other people. Vygotsky argues that the ZPD is an "essential feature of learning", as the development of these potential abilities is only possible when the learner is "interacting with people in his environment and in cooperation with his peers"(Vygotsky 1978). This implies that a learner can only realise a certain level of competence by working alone – an implication reinforced by many MMORPGs. While it is often possible for a player to "level up" by themselves, the more difficult challenges at the end of the game will typically require the player to team up with other players. In these situations, the player will use their existing abilities in combination with those of the other characters, complementing their effects and combining them in new and interesting ways. In doing so, they learn to use these abilities in a new context which would not have been possible by working alone.

- Knowledge is *theoretically constructed* by trying to explain something not fully understood

  This type of learning is quite common in computer gaming, found in most situations where "levels" are involved. For example, in an action adventure game, a player will encounter certain enemies who exhibit unique behaviours. As they progress through the game, they may meet new enemies who appear similar to those met previously. In these situations, the player can make assumptions as to how the new enemy will behave, based on the actions of the previous, similar one.

  For example, in the game "Oblivion", once a player has encountered an unarmoured Orc warrior, they can expect an armoured version to behave in a similar way, presumably with stronger defence abilities. The same principle can be applied to the game's equipment too. Having seen that an iron breastplate provides more protection than a leather one, a player can reasonably assume that a set of iron greaves will be more protective than a set of leather ones.

  Another style of theoretically constructed knowledge can be found in the vague genre of games involving some kind of mystery to be solved. As with novels and films of a similar subject, the player is encouraged to keep guessing at possible explanations throughout the game, filling in gaps with their own deductions until concrete proof is found. However, this mystery component is usually supported by some other staple gaming mechanism (First-Person Shooter, RPG, Adventure), and the player's understanding of the mystery will rarely help them succeed with this supporting mechanism.

  Situations where understanding of the mystery does help with the rest of the game are difficult to balance, and can either frustrate the player if the game becomes

too difficult without finding the necessary clues, or bore the player if the mystery can be "guessed" through trial and error.

### 2.2.2 Behaviourism

Behaviourist theory suggests that if a behaviour is reinforced by positive consequences (a process known as "conditioning"(Watson 1997)), the subject is more likely to repeat that behaviour in the future. In this way, "learning" is the increase in probability of a behaviour based on past reinforcements, such that antecedents include the consequences of the learner's previous actions.

This type of reinforcement is often present in computer games. For example, if a player does well enough in a First-Person Shooter to defeat an enemy, they may be rewarded with a more powerful weapon. In "Half-Life 2", the player typically achieves this by defeating an enemy, and taking their weapon for themselves. This weapon not only acts as a reward for success, but also as a tool for replicating the actions which granted the success in the first place. The player can use the weapon to more easily defeat the next enemy, resulting in another dropped weapon or piece of equipment as a reward. In this way, as the player continues to be rewarded for their success, the rewards encourage them to replicate the actions to repeat the success.

This perform-reward-replicate pattern can be observed in many more types of computer game. Extra in-game money allows players to buy more effective equipment; access to new locations offers new opportunities to perform; new information will enable the player to exploit their opponents' weaknesses more effectively. All of these methods reward the player in such a way, that they can use the reward to replicate the behaviour which earned it for them in the first place.

The "reinforcement schedule" – the rate at which rewards are given – is crucial to effective Behaviourist learning (Amsel 1962)(Machado 1989)(Stebbins & Lanson 1962), and can be complex to plan out. If the rewards are too few, the learner will become unmotivated, disheartened by the amount of work they have to do in order to achieve them. If the rewards are too numerous (or too powerful), the learner can simply abuse the power gained through the rewards to achieve their goals, instead of actually calling on the behaviour they have learned in order to succeed.

This pacing is somewhat analogous to the pacing of rewards in game design. If the game designer offers too few rewards, the player will be unsure as to whether their actions are correct or not, and may become frustrated with this uncertainty. However, if too many rewards are given too quickly, a positive feedback loop occurs, and the player's rewards become more powerful more quickly than their opponents do. In this situation, the player will find the game increasingly easier until there is little challenge at all, removing the player from the "flow" zone, and decreasing motivation.

### 2.2.3 Vicarious Learning

Vicarious learning utilises the concept of apprenticeships: an acknowledged, experienced master is at the centre of the learning activity, with the learners occupying a community of practice around them. The learners observe the master's actions, retain the knowledge of how they were carried out, then replicate them in future situations (Cox, McKendree, Tobin, Lee & Mayes 1999).

The way that this observe-retain-replicate pattern is carried out, can be categorised by one of the following types:

- **Modelling** – this is where the learner duplicates the master's behaviour exactly. This typically takes place at the early stages of learning, where the importance lies in being able to perform an action correctly, rather than knowing how and when to apply it in the future. Similarly, it is typically adopted by game players in the early stages of playing a game, either by watching another play first, or by watching others play at the same time during a multiplayer match.

- **Eliciting** – where the learner "re-models" the master's behaviour, applying it to a new situation. This is typically the next step in learning a technique – once the learner can replicate the master's actions in a specific practice environment, they can proceed to apply it in a number of similar, but different situations. This happens in gaming too, where players might watch another player perform actions successfully on one level of a game, before replicating these techniques successfully on a different game level.

- **Disinhibitory** – this is where the learner allows themselves to perform a behaviour from which they previously refrained, after seeing another person "getting away with it". In gaming, this typically occurs when a player exploits a bug in the game, "breaking" it to their advantage.

  A good example is the "rocket jump", present in "Team Fortress 2" and most other online multiplayer First-Person Shooters. Here, a player fires a missile at the floor just after jumping, in order to jump to previously unreachable heights. Common sense would suggest that firing a missile at your own character's feet would be a bad idea, so no players initially thought to try it. But once the exploit had been found, and players began to see others demonstrating it safely, it became common practise.

- **Inhibitory** – where a learner refrains from a behaviour after seeing another punished for it. Like modelling, this is typically used when a group are just starting to learn a particular technique. By watching their colleagues try something and subsequently fail, a learner knows not to replicate the same behaviour. This is exactly how the behaviour occurs in a new, online multiplayer game. For example,

in an action shooter game, by watching their team-mates run in front of sentry guns, attack tanks with anti-infantry weapons, or take an unprotected route to the enemy base, players can see that this behaviour will end in failure.

### 2.2.4 Motivation

Motivation represents a person's will to continue with a task. In learning, motivation is important, as it allows the learner to press on with their learning activities and to understand all that there is to teach. Without sufficient motivation, the learner will be more likely to give up before completing the learning activity, failing to meet their intended learning outcomes.

The type of motivation ranges between intrinsic and extrinsic (Ryan & Deci 2000). Intrinsic motivation concerns doing something for its own sake – the activity itself is its own reward. Extrinsic motivation concerns doing an activity for some other reason, such as improved social recognition or some tangible prize.

The types of motivation which should be used in a given learning context should also be considered in relation to the attitudes of the learners involved. Some example motivational attitudes – all placed on the sliding scale from intrinsic to extrinsic – might include the following:

- **Expressive** – this is the purest type of intrinsic motivation. Here, "the task is perceived to be playlike" (Sandelands, Ashford & Dutton 1983), and the learner carries out the activity purely for its own sake, with satisfaction gained from simply understanding the new concept. This type of motivation can be fostered by clear feedback, both for success and failure. If the learner only wishes to succeed in completing the activity and understanding its content, it is important to let them know how well they are doing at this task.
- **Achievement** – this is slightly different to expressive motivation, in that the learner merely wishes to succeed in a general sense, rather than in the particular task itself. Here, the learner's goal is to "develop or demonstrate – to self or to others – high ability, or to avoid demonstrating low ability" (Nicholls 1984). Mastery of a skill represents something important to the learner, and the task in question is merely another skill to be mastered. While motivationally different to expressive motivation, the importance of feedback still remains. This again allows the learner to know when they are succeeding or failing, motivating them to continue as they are, or to change their approach to correct their failures.
- **Social** – here, the learner wishes to complete their learning objectives in order to gain social standing or acceptance into a group (Feather 1996). For this type of motivation to exist, whilst the learning activity itself need not be social, the

details of the learners' success should be. In this way, the society involved knows of the relative successes of its other members, driving a socially motivated learner to do as well as they can.

In computer gaming, this type of behaviour is evident in online multiplayer games, such as First-Person Shooters (where successful players are invited to join prestigious "clans"), or MMORPG's (where players join "guilds" within the persistent world). In both cases, other game players are able to see these players' new affiliations, making their attainment a motivating factor.

- **Instrumental** – an extrinsic type of motivation, here the learner pursues their learning outcomes as a "means to an end" (Sandelands et al. 1983), purely for some tangible reward. These types of rewards exist in many different types of game, but typically they can only be used within the game itself. For example, new equipment gained from defeating a powerful enemy in a Role- Playing game represents a "tangible" reward, yet one that can only be used within the virtual world. Played online, these rewards can be "used" in the real world, but only as symbols of status, lending themselves more suitably to social motivation.

### 2.2.5 Bloom's Taxonomy of Cognitive Skills

Bloom divides the cognitive skills associated with learning into six categories: remembering, understanding, applying, analysing, evaluating and creating (Forehand 2005). Each of these categories encompasses a number of different skills, many of which could be catered for by modern computer gaming mechanisms:

- **Remembering** – *recalling information, recognising, listing, describing, retrieving, naming, finding.* Very few games rely on simply recalling information without applying it in some way. However, when twinned with the concepts of finding and retrieving, they form a large part of the gameplay experience offered by classic adventure games. Here, players are faced with with various puzzles and errands within the game world, and whilst ultimately the player needs to understand (or at least apply) the knowledge they discover in order to solve the puzzles and win the game, they must still spend a large part of the game discovering it in the first place.

- **Understanding** – *explaining ideas or concepts, interpreting, summarising, paraphrasing, classifying.* Modern video games require the player to process large amounts of information if they are to succeed in achieving the game's goals. Input control methods, properties of different resources, abilities and activity patterns of opponents – a player will need to understand all of these mechanisms, both independently and in relation to one another, if they are to overcome the challenges posed by them.

- **Applying** – *using information in another familiar situation, implementing, carrying out, using, executing.* At a very basic level, any well-designed game will require players to recall information they have learned, and apply it appropriately later on. Knowing when to use each weapon in "Battlefield 2", which combination of roles to use in "Lemmings", or which type of power station to build in "Sim City" all rely on the player's ability to take information they may have learned earlier (perhaps in a tutorial or training section of the game), and use it in a familiar situation within the game proper.

- **Analysing** – *breaking information into parts to explore understandings and relationships, comparing, organising, deconstructing, interrogating, finding.* This type of activity will usually come once a player has begun to master the basic gameplay. Once satisfied with their understanding, a player may start to investigate the workings of the game more closely in an attempt to further their understanding of it. By determining how the game works, the player will be in a position to use the game's mechanisms to their advantage, increasing their ability.

  This behaviour is most exhibited in games with intricate interrelationships between game items, such as traditional Role-playing games, where every weapon, piece of armour, magic potion and other item will have numerous statistics determining how well it works in certain situations, as well as which situations it can actually be used in. Only by using a form of game theory "Min-Maxing" can a player work out the perfect combinations of these items, granting them the highest chance of success.

- **Evaluating** – *justifying a decision or course of action, checking, hypothesising, critiquing, experimenting, judging.* A well designed game should always provide players with genuinely meaningful choices. If the course of action a player takes has no impact on what follows, then there is no need for the choice to be offered. As such, a player faced only with these "meaningful" choices will consistently have to justify their course of action, as they know it will have a real impact on what happens next. In addition, as games move away from traditional "3 lives and you're dead" models of old arcade titles, players are encouraged to explore and experiment. Thanks to situationally-aware "quick-saves" such as those found in "Half-Life 2", players are now able to try things out knowing that, if they fail, they can continue from just before the point of failure with no adverse implications.

- **Creating** – *generating new ideas, products, or ways of viewing things, designing, constructing, planning, producing, inventing.* Whatever the type of game, the player will need a strategy if they are to succeed. Whether planning which order to build things in "Civilization IV", deciding which troops to attack with in "Company of Heroes", or which combination of party members, magic and skills to use in "Final Fantasy X", a player will have to develop strategies to succeed. These strategies will need to change as the game-state changes, forcing the player

to generate new ways of understanding things once their old strategies become useless.

### 2.2.6 Scaffolding

Scaffolding is a technique put forward by Wood, Bruner and Ross (Wood, Bruner & Ross 1976). It involves creating a learning activity with a number of different sub-tasks to be considered. At first, the majority of these sub-tasks are completed automatically, with the learner concerned with only a few. As they gain proficiency in the sub-tasks, they are granted control over more of them, until they are ultimately able to understand and control them all. In this way, the learner is slowly eased into a learning activity, only progressing onto more difficult tasks once they are proficient enough in the initial ones.

This type of system rarely happens within computer gaming. In a scaffolded environment, all tasks are made apparent from the start, with most being controlled automatically. Conversely, a typical game will not introduce a gaming concept at all until the player is ready to use it. In this way, the player is never expected to control a mechanism for which they are not ready, but at the same time, they lose out on the ongoing context found in a scaffolded environment.

However, there are some gaming types which lend themselves to a scaffolded system. Many vehicle simulation games offer a number of "driving aids", such as automatic gears, braking assistance, or a suggestion of which gear to use for a given corner. A novice player can leave these aids turned on, concentrating on approximate speed control and steering while they acclimatise themselves to the game. As they grow more confident, they can turn the aids off, granting more control over the system at the cost of added complexity.

Tactical squad-based combat games may also afford a level of scaffolding to the player. As well as controlling their own in-game avatar, the player (taking the role of squad leader) may be given a number of simple commands to give to their team mates, e.g. "cover me", "assault that position", or "protect the hostage". At a low difficulty level, these orders may be "given" automatically by the computer, allowing the player to focus purely on their own role within the squad. Once the player moves onto a higher difficulty, they can give the orders themselves, making them responsible for their own actions as well as those of their whole team. Again, this allows the player to get used to a complex game system without initially having to understand all of its intricacies, while at the same time exposing those intricacies once the player is ready.

### 2.2.7 Gagné's Nine Steps of Instruction

Gagné identified the following nine steps involved in successful instruction (Gagné 1984). While originally taken from traditional learning activities, the steps can be applied to the way in which many modern games teach players to play. The steps are as follows:

1. **Gain attention** – in a game context, this may be somewhat unnecessary. The player has already chosen to play the game, and is sat in front of a television or computer ready to play. However, most games will have an introductory cut-scene, or piece of plot exposition to hook the player before starting.

2. **Inform learner of objective** – goal provision is a key element of good game design, and is reflected in this stage of Gagne's list. The player may be informed of the long-term goal of the game, the short-term goals of the current level, or immediate goals of the current task in hand. Regardless of the type of goal, the player should be made well aware of it if they are to be expected to a achieve it.

3. **Stimulate recall of prior information** – an initial training level could be used here, encouraging the use of transferrable skills from other games of the same genre, e.g. moving and rotating blocks in a puzzle game, or selecting and directing units in a Real-Time Strategy.

4. **Present new information** – with the player now able to replicate these "standard", genre-wide techniques within the current context, the game can begin to demonstrate interactions specific to the game itself. This may include the concept of using "hyperspace" travel in a space combat simulator, the ability to revive fallen comrades in a squad-based combat game, or the distribution of taxes in a city development game.

5. **Provide guidance** – having alerted the player to these new possibilities, the next step is to explain how they work. This could be a simple matter of explaining the required input controls, or having another in-game character demonstrate the action for the player to replicate later.

6. **Elicit performance** – now that the player theoretically understands how to carry out the new action, the game should ask them to prove this. In the early stages of the game, this should typically be in a contrived "training" situation, with little opposition other than from the task itself. For example, a combat game may train the player to shoot in a shooting range, or a construction game may remove opponents to prevent them building on the player's territory.

7. **Provide feedback** – having attempted to demonstrate their ability, the game informs the player of their immediate success or failure. Audio and visual cues are typically used here, showing players whether they have hit targets, built in the

correct place, driven along the correct route or performed the correct combination of button presses.

8. **Assess performance** – this works alongside the provision of feedback. Once the player has successfully accomplished the tasks set by the game, they will be free to continue onto the next stage. If they fail to perform satisfactorily, the game may hold them back and explain where they went wrong, asking them to repeat the task until they can complete it.

9. **Enhance retention and transfer** – Once the player has demonstrated their ability to perform these tasks successfully, the game will offer situations similar to the ones encountered during training, forcing the player to re-use their existing skills in new contexts. As the nine steps (or sub-sets of them) are repeated throughout the game, the new skills learned will need to be combined with those already understood, again encouraging the player to use their skills within new contexts.

### 2.2.8 Honey and Mumford's Typology of Learners

Honey and Mumford propose a typology of learners, categorising the different ways in which people approach learning (Mumford 1995). These categories align with the learning categories described in Kolb's "Learning Cycle" (Kolb & Kolb 2005): "*concrete experience*", "*reflective observation*", "*abstract conceptualisation*" and "*active experimentation*".

Honey and Mumford's learner types are as follows:

- **Activist** – this kind of learner prefers learning through doing and experiencing, in line with Kolb's "*concrete experience*" type. As interactive experiences, games should appeal strongly to this type of learner, as whatever the genre of game, it will still require the player to interact with it, performing tasks in order to progress.

- **Reflector** – preferring to engage in a "*reflective observation*" style, this type of learner observes the way in which a system works, and reflects on the evidence that emerges. While this type of learning is not typically fostered directly by games, there are certain situations where it may be possible.

  For example, the "Gran Turismo" series of driving games features a set of "driving tests", where players must complete isolated driving tasks in order to earn a licence and be allowed to race. Each of the tasks within a driving test has an accompanying "replay" of the task being completed perfectly. During the replay, the player is free to change camera angles and to display car telemetry details, in order to get a clear picture of how they should be driving. Once they are confident that they understand what needs to be done, they can attempt the test properly.

Even where reflective learning techniques are not implemented within the game, this type of learning could certainly form an important part of a player's experience. As with the "modelling" stage of vicarious learning, a novice player may simply watch others play and attempt to replicate their actions as a way of getting started without having to fully understand how the game works. However, without later moving onto another style of learning, the player may be left with an incomplete understanding of the game's underlying principles.

- **Theorist** – this type of learner will use "*abstract conceptualisation*" to understand the underlying concepts and relationships of a particular system. There are plenty of gaming experiences that could offer this opportunity to the player: understanding the different political, economic and military relationships in "Civilisation IV"; "min-maxing" your avatar's weapons, spells, armour and equipment in "Oblivion"; understanding the different impact velocities and spray patterns of the different weapons in "Counterstrike". All of these games are supported by richly-defined back-end models, which can all be explored and understood by simply reading about the game, or by playing it.

- **Pragmatist** – pragmatic learners enjoy "*active experimentation*", toying with a system and trying things out to see how they work. Modern gaming is becoming more hospitable to this type of learner, with an increase in the number of available "sandbox games" – games where instead of a linear, step-by-step route to completion, the player is given their goals, then left to accomplish them however they like. This gives the player much more freedom to try things out, experimenting with the game's possibilities without the restrictions of a more traditional, linear game.

While learners were identified within these four categories, Honey and Mumford's original intention was to highlight the need for *all four* styles to be incorporated into effective learning. The identification of a learner as a specific type should act as an indication that practise may be required in the other areas.

Games can help to foster this practise, by using feedback to make sure a player has the appropriate skills to progress. For example, if a player loses a particular race in a driving game, they may be required to try that race again until they win. In making the player retry, the game forces them to practise the specific task in which they lack proficiency. This process can be repeated until the player wins the race, demonstrating that they have achieved the required level of skill in driving on that particular course.

In supporting Honey and Mumford's learning types, a game section may rely on one (or more) of Kolb's activity types, requiring the player to complete the activity before moving on. By forcing the player to repeat the activity until they succeed, the game will ensure a particular level of competence in that activity, as well as providing the opportunity to gain it through practise.

### 2.2.9 Analysis

To understand these learning styles within the context of a learning environment – and by implication, an educational game – it would perhaps be useful to consider them in relation to the requirements generated previously. Tables 2.2, 2.3 and 2.4 show the learning styles identified in this chapter, along with the "learning environment" requirements from Table 2.1 which might reasonably benefit their implementation. Each of the learning styles shows quite a different set of requirements, although some similarities do exist.

Honey and Mumford's "pragmatists" share most of their requirements with Bloom's "creators". Both types of learner are characterised by their tendency towards "active experimentation", trying out new things and observing the results. As such, both types of learning are likely to benefit from a demonstration of new knowledge along with an environment in which to explore it. In addition, useful, timely feedback and an opportunity to contextualise what they have learned within their existing mental models would be helpful in this type of learning.

Perhaps surprisingly, Honey and Mumford's "theorists" share a lot of their requirements with constructivist learners. Both types of learner require new knowledge, along with the opportunity to contextualise it through useful feedback. However, their dependence on "exploration" can be seen differently for each type of learner.

The constructivist learner will literally explore the environment: moving around the "physical" space represented within the game, observing and experimenting with the information it has to offer. The theorist, however, will effectively be using the environment to "explore" the information itself more directly. Where the constructivist explores the environment with new knowledge emerging as a result, the theorist explores with the specific *intention* of discovering the knowledge that drives the environment. Both learners explore, but with different motivations.

This is reflected in the different ways that curiosity can drive the two types of learner. A constructivist learner's curiosity should be provoked to lure them into new areas *within* the environment, encouraging them to interact with its contents in new and interesting ways. The theorist, however, should be provoked to explore the rules and relationships *behind* the environment. In practical terms, this may be implemented in the same way as for the constructivist learner – by exposing the theorist to more interactions within the environment, more opportunity arises for the learner to understand the underlying mechanisms. While the environmental considerations are perhaps the same, the intentions (and the learning which takes place as a result) are quite different.

TABLE 2.2: A list of different learning styles mapped to the requirements harvested from previous workon learning environments

| **Criterion** | **Constructivist** | **Behaviourist** | **Scaffolding** | **Vicarious Learning** | | | |
|---|---|---|---|---|---|---|---|
| | | | | **Modelling** | **Eliciting** | **Disinhibitory** | **Inhibitory** |
| Conversation | X | | | X | | | |
| New knowledge | X | | X | X | | | |
| World creation | | | | | | | |
| World exploration | X | | | | | | |
| Useful feedback | X | X | X | | | X | X |
| Balance difficulty | | X | X | | | | |
| Clear goals | | | | | X | | |
| Contextualisation | X | | X | | X | | |
| Provoke Curiosity | | | | | | | |
| Immersion | | | | | | | |
| Offer rewards | | X | | | | X | |
| Unite resources | | | | | | | |
| Blended support | | | | | | | |
| Full pedagogy | | | | | | | |
| Standards | | | | | | | |

Table 2.3: A list of different learning styles mapped to the requirements harvested from previous work on learning environments

| **Criterion** | **Motivation** | | | | **Bloom's Taxonomy of Learners** | | |
|---|---|---|---|---|---|---|---|
| | **Expressive** | **Achievement** | **Social** | **Instrumental** | **Remembering** | **Understanding** | **Applying** |
| Conversation | | | X | | | | |
| New knowledge | | | | | X | X | X |
| World creation | | | | | | | |
| World exploration | X | | | | | | |
| Useful feedback | X | X | X | | | | |
| Balance difficulty | | | | | | | |
| Clear goals | | X | X | | | | X |
| Contextualisation | | | | | | X | X |
| Provoke Curiosity | | | | | X | X | X |
| Immersion | | | | | | | |
| Offer rewards | | | | X | | | |
| Unite resources | | | | | | | |
| Blended support | | | | | | | |
| Full pedagogy | | | | | | | |
| Standards | | | | | | | |

TABLE 2.4: A list of different learning styles mapped to the requirements harvested from previous work on learning environments

| **Criterion** | **Bloom's Taxonomy of Learners** | | | **Honey & Mumford** | | | |
|---|---|---|---|---|---|---|---|
| | **Analysing** | **Evaluating** | **Creating** | **Activist** | **Reflector** | **Theorist** | **Pragmatist** |
| Conversation | | | | | | | |
| New knowledge | X | X | X | | X | X | X |
| World creation | | | X | X | | | X |
| World exploration | | | | X | | X | X |
| Useful feedback | | X | X | | X | X | X |
| Balance difficulty | | | | | | | |
| Clear goals | X | X | X | | X | | |
| Contextualisation | X | X | X | | | X | X |
| Provoke Curiosity | | | | X | | See §2.2.9 | |
| Immersion | | | | | | | |
| Offer rewards | | | | | | | |
| Unite resources | | | | | | | |
| Blended support | | | | | | | |
| Full pedagogy | | | | | | | |
| Standards | | | | | | | |

## 2.3 Conclusions

In this chapter, a number of requirements for successful learning environments have been gathered, and compiled into a single list. This list should provide a good starting point for assessing the quality of existing educational games, comparing the affordances they offer to the requirements gathered during this chapter. While some of the requirements were taken from different educational domains, the similarities in the resulting requirement sets suggest that such features could be more broadly beneficial to a wider range of education styles.

In addition, a selection of educational theories were presented, along with some initial suggestions as to how video gaming techniques could be used to uphold their principles. Computer games can provide motivation, social environments, explorable areas, experimental testbeds, feedback, support and more. By relating these affordances to educational theories and models, strong similarities appear, lending support to the idea that games can be used to implement learning activities.

The next step will be to explore gameplay mechanisms in more detail, to determine which games are able to provide each of these desired affordances. As game design techniques are explored and assessed further, a more complete picture of their educational potential can be developed.

# Chapter 3

# Game Design Discussion

Having compiled the set of requirements in Table 2.1 and introduced some educational theories and principles, we can continue to discuss the suitability of games as educational tools more reliably. We will first consider some existing game design principles, identifying areas where they integrate with the requirements established in Table 2.1. Game narrative is then discussed, exploring the importance of context within a learning environment, and how rich, dynamic narrative structures can help to support it.

## 3.1 Gameplay Mechanisms

Computer gameplay design has existed in some form for around 30 years (Rollings & Adams 2003). However, little of the knowledge surrounding it has been officially published, with the majority of available information either found on the Web (in blog posts, forum discussions, FAQ's and tutorials), or kept within the industry itself.

The discussion presented in this section takes its information from a number of sources – game designers' blogs, transcriptions of keynote speeches, discussions presented in online magazines and my own personal experiences with the games themselves. Where possible, the information is "backed up" with content from the book "Andrew Rollings and Ernest Adams on Game Design" (Rollings & Adams 2003) – one of the few books available which attempts to explain game design without deviating into 3D modelling, level scripting, or any of the other disciplines involved in game development.

### 3.1.1 Immersion

Explorable environments are fundamental to all adventure games[1] , with a high degree of contextual continuity used to immerse the gamer within the virtual world as deeply as

[1] Adventure game designer and journalist, Ben Croshaw, cites "exploration" as a key mechanism in avoiding "key-ring syndrome" in adventure game design – a situation where any puzzle

possible. Nowadays, games are placing more and more interactive functionality within the game itself, in place of processes external to the game world. For example, where a player in a futuristic role-play game might previously have used an arbitrary key-press to "bypass a security terminal", they might now find themself looking at the terminal within the game, entering commands via the keyboard as their character would in-game.

Similarly, environmental data is becoming more frequently displayed within the game world itself, replacing what would previously have appeared on an informative "heads-up display"[2]. For example, where a player's current health may have previously been displayed as a number in the bottom corner of the screen, it might now be reflected in the way in which the player moves, or in the heaviness of their character's breathing. All of this helps to detach the player from external distractions, immersing them more fully within the gaming environment.

### 3.1.2 Goal Definition

Goals are present in virtually any game, from the simplest game of naughts and crosses to the most tactically demanding siege of a Roman fort. Additionally, games will often possess numerous different goals in any given situation. For example, in a real-time military strategy game, the player may have a single primary goal of "defeat the enemy", but at the same time may have additional sub-goals such as "destroy the enemy ammunition dump" or "protect the nearby civilian settlement".

The layering of goals in this way is key to most gaming experiences, as it provides the player with explicit direction in their immediate actions, whilst simultaneously giving their actions a broader context[3]. This could be incredibly useful in an educational setting, as it not only provides the learner with immediate learning goals, but offers guidance on how to integrate these goals with their existing contextual knowledge.

### 3.1.3 Integration of New Knowledge

Guidance in assimilating new knowledge with existing knowledge is demonstrated by the way in which new skills are introduced to players within a game. Modern games typically feature "tutorial" sections before the real game begins. Here, the player is given guidance on how to use the game's functions, usually without opposition, allowing them to learn how the game works before any of their actions have a genuine impact.

---

can be solved by simply using each item in the player's inventory on an object, until one works (*http://www.adventuregamers.com/article/id,522/p,2*).

[2] "Off With Their HUDs!: Rethinking the Heads-Up Display in Console Game Design", available online at *http://www.gamasutra.com/view/feature/2538/off_with_their_huds_rethinking_.php*

[3] "Provide clear short-term goals" and "provide an enticing long-term goal" are at positions 6 and 25 respectively in "The 400" – a collaborative list of game design requirements compiled by professional game designers (http://www.theinspiracy.com/Current Rules Master List.htm)

Gee discusses the tutorial in "Rise of Nations", stating that it allows the player to "feel much more of the complexity of the whole game" while making sure that the "risks and consequences are mitigated compared to the "real" game" (Gee 2004*b*).

In addition, when granting the player a new skill or weapon, it is common in modern games to offer the player a section of gameplay focusing solely on that new feature. Once this section is complete, the player is returned to a state of play where the new ability must be used in conjunction with the player's existing repertoire.

For example, a player of a first-person 3D action game picks up a sniper rifle for the first time. The game may then present the player with an obvious vantage point overlooking a series of distant opponents. After using the new weapon to defeat these opponents, the player continues through the 3D world where the sniper rifle must be used in conjunction with their previously acquired close-range weapons, automatic rifles and explosives.

From an educational point of view, the player has been taught a new, specific skill (the use of the sniper rifle), applied it to their existing knowledge base (their current skills with an assortment of other weapons) and used it correctly in context (employed the right weapon in the right situation to combat different opponents appropriately).

### 3.1.4 Maintaining the Balance

Another inherent feature of gaming is the way in which difficulty is balanced. As a player progresses through the game (having demonstrated proficiency in the required skills), their experience will become gradually more challenging. The timing and gradient of this increase is critical to the gameplay experience (Gee 2004*b*).

If it happens too soon, or at too rapid a rate, the player will not be skilled enough to overcome the current challenges, and will be unable to progress further through the game. If the difficulty increases too slowly or too late, the player may become bored at the lack of challenge, and will lose motivation in achieving their goals. By maintaining this balance of difficulty, players remain engaged in pursuit of their goals and are more committed to following the game through to the end.

Rollings and Adams state that balancing a game is "an optimisation problem in $n$-dimensional space, where $n$ is a very large number" (Rollings & Adams 2003). However, using a "tweak-play-tweak" method, a number of different attributes can be altered to maintain a suitably balanced challenge. The number of opponents may be increased or reduced, as may their proficiency in challenging the player. Weapons or tools used to compete against them may be made more or less effective, or resources made more plentiful or scarce. Traditionally, these variables would be determined by a predetermined difficulty setting chosen at the start of the game. The higher the difficulty, the more

numerous the opponents, the more scarce the ammunition, the more inaccessible the environment.

However, using A.I. techniques such as Reinforcement Learning (Andrade, Ramalho, Santana & Corruble 2005) (Spronck, Ponsen, Sprinkhuizen-Kuyper & Postma 2006) and High-Fitness Penalising (Spronck, Sprinkhuizen-Kuyper & Postma 2004), and developing technologies such as "Hamlet" (Hunicke & Chapman 2004), games will be able to adjust their difficulty in real-time, offering the more appropriately balanced experience. For example, if a player is having a hard time getting past a certain section of a First-Person Shooter, the game may increase the number of ammunition and health packs available, or cause the opponents to run out of ammunition themselves. Conversely, if the player is finding a section very easy, the game may compensate by sending in more opponents wearing thicker armour, or may lock the door the player wants to go through, forcing them to find a key.

This kind of dynamic difficulty setting would be ideal within a learning environment, with effects similar to those of a more traditional adaptive learning environment. If a learner proves to know enough about a certain subject, the system could skip ahead, assuming the student needs no further instruction in this area. On the other hand, if a student seems to be struggling in a given situation, additional help, explained at a more fundamental level could be provided, to help the student understand the information more easily.

Bailey and Katchabaw present an experimental testbed to incorporate auto-dynamic difficulty adjustment into modern video games (Bailey & Katchabaw 2005). Their research indicates positive results, although further investigation with a more detailed game harness is required. They also propose a "proactive" dynamic difficulty engine, which establishes a player's ability from a number of non-critical in-game actions. This would have the added benefit of allowing the game to adjust the difficulty level before the player reaches any critical gameplay stages. This removes the extra, initial stage of frustration or boredom used to calibrate the existing "reactive" systems, making the experience even more tuned to the player's abilities.

### 3.1.5 Curiosity and Self-motivation

The provocation of curiosity is quite a common feature in many games, employed to force the player to make decisions. Common devices such as crates and barrels often contain rewards, encouraging players to look inside them at any opportunity. Distant platforms, locked doors and heavily guarded areas all suggest to the player that there must be something in these areas to warrant the added difficulty of reaching them.

By enticing the player to go further out of their way, or engage in otherwise unnecessary conflict, the player's curiosity is increased, driving them to make the most out

of their gaming experience. In an educational context, these kinds of lures could be used to encourage learners to further their own learning experience, without being constantly pushed by instructors. Malone suggests that in order to evoke curiosity within the player, the game should provide "an optimal level of informational complexity", such that the player "knows enough to have expectations", while making sure that the expectations aren't always met (Malone 1982). By making the player think that their current knowledge is "incomplete [or] inconsistent", the game encourages them to take actions to make their knowledge complete.

### 3.1.6 Facilitating Feedback

Opportunity for instructors to assess how well a student is performing are present in various degrees within computer gaming. At the very least, a player is typically presented with a "score" of some kind, providing a relative indication of performance compared to other participants. However, it is becoming more common for games to provide much more detailed accounts of what went on during play.

The online game "Halo 2" offered an extremely in-depth report on what occurred during a match, including the positions on the map where most combat occurred, the number and types of vehicles used by each team, and exact way-point indicators showing movements of key players. These increased levels of observational data should help paint a clearer picture of how a student performed, allowing more valid feedback to be generated.

In addition, it is quite common for games to offer action replay functionality, allowing others to observe a player's exact actions within a single game. This kind of functionality could prove invaluable to instructors wishing to provide feedback, as it could be generated based on precise viewings of replay data, then explained to the student whilst watching the replay, allowing the student to see exactly which of their actions the feedback applies to.

## 3.2 Game Narrative

The quality of narrative in games is often seen as its weakest point. Whilst a small percentage of game developers excel in their storytelling abilities, most games feature trite revisions of the same ancient narrative mechanisms, "flat and stereotypical" characters and "weak and predictable" plots (Dormans 2006). Much of the reasoning behind this lack of narrative quality comes from the player's requisite involvement in the unfolding story.

In his lecture at the Game Developers' Conference 2005 (Adams 2005), Ernest Adams identified three main problems with in- game narrative, along with a selection of poorly-suited solutions currently in use. These problems were identified as:

- *internal consistency* – how do we keep the story consistent when the player (and therefore in most cases, the main character) is out of our control? Possible solutions include making either the character or story so dull, that there *are* no actions to perform which could make the story inconsistent, or to perform these actions automatically without any player input. These are poor work-arounds, as they hinder the potential of the narrative and the interactivity respectively.
- *narrative flow* – how do we make sure the player is ready for any dramatic twists exactly at the moment they occur? Currently, we either force the player down a narrow series of predetermined checkpoints (limited interactivity), or tie key points in the story onto very specific player actions (less interesting narrative) – neither solution is ideal.
- *amnesia* – how do we deal with the fact that the protagonist understands their world, but the player does not? The only real solutions to this problem seem to be the telling of stories where the protagonist does in fact have amnesia, or is faced with some kind of unsolved mystery. Whilst these scenarios work to some extent, they are hardly exhaustive of the genres we are likely to want to cover.

### 3.2.1 Discussion

These problems would certainly need considering when designing a narrative-driven game, but why do they matter from an educational point of view? Surely, if we try to make a game to teach players about Shakespeare's "Julius Caesar", or George Orwell's "1984", the narrative structure is already written for us – by some of the most acclaimed authors in history, no less. Indeed, the problems still stand, because whilst the narrative in these books could be considered excellent, there is no interactivity whatsoever. For the novel or play to become a game, interactivity is required; as soon as interactivity appears, all of the problems of narrative start to occur. This balancing act between narrative integrity and engaging interaction is where the real issues of gaming narrative lie.

Used within a "normal" educational context, player amnesia shouldn't be too much of a problem. If the learner has already read the corresponding text, any information about the players world should have already been exposed by the author's original methods. However, the internal consistency of the story can become problematic as soon as the player tries to deviate from the original plot. In the example of Julius Caesar, what would happen if the player caught wind of the conspiracy, and fled the country before his assassination could be carried out? Perhaps this instance could be hard-coded into the game, as a kind of "alternate ending". But what if before fleeing, he had Brutus killed? What if he had him publicly executed? What if, having fled Rome, the player were to return 10 years later to seek his revenge? As more and more potential actions are identified, the solution of hard-coded outcomes becomes less and less useful.

One possible solution to this problem is the use of rich, well-defined relationships between all of the characters in a narrative. Used correctly, this would allow the characters to react intelligently and appropriately to any input made by the player. This would allow a much more varied selection of interactions to take place than if a finite number of hard-coded outcomes were implemented. Taking the hypothetical example of Caesar returning to Rome after 10 years, the benefit of these relationships can be seen. Were we to hard code the outcome, we could probably implement a fairly convincing city with a new governement in place. But what if the player decided to return 5 years later, or even several months later?

If, instead, we rely on a set of well-defined relationships and behaviours to generate an entirely emergent city, it makes no difference when the player returns. If implemented correctly, the player will find the city in an appropriate state of administration based entirely on the relationships defined in the underlying behavioural map. Obviously, making an appropriate map for something as intricate as imperial Rome would be quite a feat, but the principle remains sound – as long as sufficient behaviours are defined, emergent behaviour could be as convincing as any hard-coded effort.

But why is this kind of experimentation important in an educational context? An interesting parallel can be drawn with the results found in Squire and Barab's paper "Replaying History" (Squire & Barab 2004). In their study, a small class of underserved, inner-city american schoolchildren were given the opportunity to use the game "Civilization III" to assist their history studies.

Focusing on the cultural, economic and political development of a number of famous historical civilisations, the game's back-end is served by an incredibly well-defined model of the many aspects affecting such development. Make alliances which, in turn, make enmities with the enemies of your new friend; make too many of your people work or go to war, and risk revolution amongst your unhappy citizens; focus your economic growth on a single abundant resource, and risk bancruptcy when it finally runs out. This well-defined model appears very similar to the rich narrative structures explained earlier.

The results of the study showed that, once the initial complications of learning the game were overcome, the students found the experience to be most helpful. Where previously they had been tought to memorise facts and dates, students were now encouraged to "replay history", trying out different tactics to those used historically, and observing the intelligently generated behaviour which resulted. Students were able to see the importance of colonisation to old-world civilisations, the need for horses in historical combat and the importance of trade amongst nations for successful development. They were able to "reverse engineer" migratory paths of Native Americans and Viking settlers in an attempt to reach Europe from America before the Europeans arrived on their shores.

All of this experimentation resulted in appropriate outcomes thanks to the well-defined set of interdependencies between the different units in the game, which in turn could act as a valuable learning resource. Students found they had to know about the various nations within the game in order to win. Combined with in-class discussion and a series of scenarios to play out, students were able to experiment and gradually understand more about the game (and in turn, world history), allowing them to contextualise and therefore better understand any emergent events, as well as those which actually happened.

This contextualisation as a result of experimentation in an experiential environment has already been identified as a key part of Laurillard's Conversational Framework, and could work equally well or narrative structures. By allowing learners to experiment with different scenarios to those found in the original narrative, they should be able to better contextualise the events which do occur within it. Once again, experimentation, experience and contextualisation provide a valuable learning benefit.

## 3.3 Conclusions

This brief examination of gameplay mechanisms shows that all of the requirements generated in the previous chapter are either present in games already, or could be easily created by combining existing game technologies. This ability to support educational requirements suggests that computer games can indeed be suitable learning environments. However, as these different requirements appear to be satisfied by different games and gameplay mechanisms, we should probably consider the different types of game individually when determining how well they suit a given educational aim. To expand on this idea, further attention will now be paid to the "Massively Multiplayer Online Role Playing Game" (or "MMORPG") genre, to identify which particular requirements it fulfils most successfully.

# Chapter 4

# MMORPG's

There has been a recent increase in interest regarding the usefulness of Massively Multiplayer Online Role Playing Games (MMORPG's) within educational contexts. These games take place in large, persistent online worlds, with hundreds of players involved in the game at any one time. Most often, the social aspects of such games receive the most attention when assessing the genre's educational merits. However, many of the gameplay mechanics involved in MMORPG's could prove to be just as useful as the social benefits.

## 4.1 Scientific Habits of Mind

Steinkuehler and Chmiel discuss the pros and cons of MMORPG's in their paper "Fostering Habits of Mind in the Context of Online Play" (Steinkuehler & Chmiel 2006). The paper looks at how MMORPG's foster a "scientific habit of mind", in that they encourage players to think in a scientific manner, rather than just expect them to remember a series of scientific facts. The ability to reason on these facts instead of just remembering them represents a significant change for the better in the way a number of science courses are taught, by encouraging "the widening spread and deepening hold of the scientific habit of mind"(Dewey 1910). The use of MMORPG's which encourage these ways of thinking could bring about this change more quickly.

The paper goes on to suggest that games are "simulated worlds", allowing players to build situated understandings of phenomena, instantiated in a world which makes them relevant. This ties in well with Laurillard's "experiential environments", providing learners with a contextually relevant world in which to exercise their conceptual models. The authors also state that past ethnographic studies (Steinkuehler 2004) (Steinkuehler 2005) have revealed MMORPG's to be "naturally occurring learning environments", providing opportunity for scientific argumentation, model-based reasoning, formulation of strategies and research into previous work.

In order to determine how well these features worked, Steinkeuhler and Chmiel assessed a thread on the "World of Warcraft" forum, using the AAAS benchmarks for scientific literacy [1]. This seemed appropriate, as the forum is a fair representation of the "collective intelligence" surrounding the game. Contribution to this "collective intelligence" is highlighted as a strong source of motivation within most MMORPG's, and as such could be useful in motivating learners.

It was discovered that forum users were good at contributing to the social knowledge with reasoning based on mathematical models. These models were used to generate rational arguments and counter-arguments, with users often referencing the work of others who had played the game and contributed previously. This style of social learning could be defined as a "Community of Practice" (Wenger 1998), with players "*mutually engaged*" in a "*joint enterprise*", using a "*shared repertoire* of communal resources".

However, the discussion failed to grasp the pragmatic nature of scientific discussion, with players assuming that just because a model has held true so far, it will remain true in all future situations. This is possibly due to the finite, noise-free nature of the game world, where a process of reverse engineering will uncover a solution which will always work. This also led to largely algorithmic discussion, resulting in few truly generalisable concepts.

In conclusion, the authors suggest that a good MMORPG should:

- *offer multivariate problems of real social import* – different kinds of problems help to keep boredom at bay, whilst their social importance motivates players to keep up with their peers.
- *understand that problem-solving requires distributed, simultaneous activity, partially overlapping, partially conflicting* – by forcing this kind of simultaneous social activity – either collaboratively or in conflict – the game remains genuinely social, retaining the associated benefits.
- *provide opportunity to contribute to a collective intelligence* – as with the first point, the ability to contribute something of worth to a collective pool of knowledge appears to be excellent motivation for players to do well in the game.
- *prompt users to meta-reason on the function and role of the simulation* – this helps users to consider how their in- game activity can be applied to real-life contexts, helping to move away from the algorithmic, game-specific discussion observed during the study.

[1] American Association for the Advancement of Science – http://www.aaas.org/

## 4.2 Alone Together

In their paper "Alone Together? Exploring the Social Dynamics of MMOG's", Ducheneaut *et al.* discover that the social aspects of MMORPG's are not as prevalent as it was once thought (Ducheneaut, Yee, Nickell & Moore 2006), with most social activity "characterized by short interactions centered on instrumental purposes"(Ducheneaut & Moore 2004). In their study, the authors harvested actual in-game data, instead of carrying out the usual interviews and ethnographic observations. A server- wide census was carried out once every 5 to 15 minutes, recording details such as the users' level, name and whether they were grouped or not.

The results of the survey were interesting, showing that players rarely grouped together at all during the main "leveling up" sections of the game. Players resorted to grouping only once the end-game was reached, where they were required to form raiding parties of specific sizes in order to participate. This is reflected by Hobbs *et al.*, where grouped players are described as a "community of practice", with players "who share a concern or a passion for something they do, and learn how to do it better as they interact regularly" (Hobbs, Brown & Gordon 2006). In this case, the shared concern is over defeating an end-game enemy, with regular group attempts ("raids") helping the players to improve.

The ungrouped "leveling up" time is described as being spent "alone together", where players are surrounded by others, but are not strictly "with" them. It appeared that the sense of duty provoked by being part of a guild caused players to work together for longer, but not by a particularly impressive amount – on average, any two guild-mates played together for around 20 minutes per month, with guild-mates from a closer "core group" still only playing together for around 150 minutes during the same period. When we consider that many players play the game for several hours per night, several nights per week, this time spent together seems somewhat insignificant.

However, would any of this really be a problem in an educational environment? During group exercises, learners will often need to be pushed into working with people they know less well, ahead of their close friends (Blatchford, Kutnick, Baines & Galton 2003), regardless of the type of activity involved. And it would be something of an annoyance for instructors if learners decided to move around during a lesson and form groups at any time other than when it was specifically required of them. The result of an MMORPG provoking group work between close friends at specific times in a "virtual classroom" would be analogous to the current behaviour in a "real" classroom, where learners group together to perform specific tasks, whilst remaining "alone together" with the rest of their class-mates.

## 4.3 Leveling Up

Several other features of the MMORPG genre can be considered beneficial in relation to the values compiled in Table 2.1. The concept of well-defined goals is well established in the MMORPG genre. Whilst there is some variety between titles, the fundamental concept remains the same: perform set tasks in the environment to enhance your avatar's attributes, gaining access to further tasks and environments.

This format highlights two useful paradigms for educational gaming. Firstly, the quests themselves act as "well-defined goals", as established in our list of requirements. These quests always ensure that users know where they need to be and what they need to do (e.g. "Go to X mountain range and collect 5 instances of Y"). The rewards provided on completion serve to motivate the player in pursuing their goals to the end.

Secondly, the way in which the avatar's attributes are enhanced is interesting. In many games, a "level" structure is employed whereby on completing an area of the game, the player is granted access to the next area, or "level". Here, progress is measured in terms of how much of the task in hand has been completed. In MMORPG's, whilst new areas become accessible upon completion of certain quests, the real concept of "leveling up" focuses on the player themselves. Rather than measuring success based on how far through the task a player is, these games measure success by how well-developed the player's avatar – and by proxy, the player themselves – has become. This aligns with the idea that education should aim to expand beyond course completion, towards competence and confidence within a subject area (Koper & Olivier 2004).

## 4.4 Curiosity

In addition, the concept of "side-quests" presents some interesting issues regarding learner curiosity. Many "core" quests are available at a well-known central location, which adds to their well-defined nature. However, more adventurous players can seek out additional side-quests – tasks which are harder to find, more difficult to complete and as a result, offer more prestigious rewards for their completion. In an educational context, this would enable all learners to attain a basic level of competence by completing the "core" quests on offer. More adventurous learners, however, can seek out 'side-quests" at their own pace should they wish to do so, rewarding proactive behaviour with a greater level of course competency.

## 4.5 Walking Before You Can Run

The way in which the areas of the game world are unlocked in MMORPG's also poses some interesting ideas. In most games in the genre, certain areas of the game are locked until a certain player level is reached. As levels are gained by completing tasks, it is inferred that the locked areas only become accessible once the tasks themselves have been completed.

This is an excellent way of providing balance between boredom and frustration: by keeping the areas locked until a certain level of competence has been acquired, a player should never find themselves in an area too difficult to deal with; by unlocking the new area as soon as the required skills have been gained, the player is free to move onto new tasks as soon as they are able. The quicker they learn, the quicker they can leave.

The way in which players are *allowed* into the new areas rather than *forced* into them also works well with the shift towards course competency. Strong players can move ahead straight away, whilst weaker players are free to stay in the current area, developing their skills further before moving on.

## 4.6 Apprenticeships

In another of Steinkuehler's papers, the concept of "Apprenticeships" are introduced (Steinkuehler 2004). Here, players who are new to the game elect to team up with more experienced players, as an alternative to reading printed or online manuals. In this way, any instruction is given "just in time" – it is always appropriate to the current scenario, and can be augmented or replaced with new information by the experienced player as required. This displays an almost adaptive quality, with learners only being given the information that they explicitly require at a given time. This again ensures that the learner is always given sufficient instruction to proceed, but is never bored by information which has already been learned. It also gives the experienced player an opportunity to contribute to a kind of communal knowledge, albeit to a much smaller community that previously identified. Being asked to explain the subject matter to new learners, the experienced player is encouraged to scrutinise their own understanding of the information, potentially helping them to identify any areas which they don't fully understand.

## 4.7 MMORPG's – a Bittersweet Pill

While MMORPG's offer a number of advantages from an educational perspective, they are not without their problems. One immediately apparent problem when loading an

MMORPG for the first time, is the complexity involved in controlling the game. In his paper "MMORPG's in the College Classroom", Aaron Delwiche (Delwiche 2003) describes the difficulties his students had when trying to play Everquest, as part of an in-class ethnography study. Within minutes of starting the game, students found themselves being attacked by bats, rats and halflings, or even drowning. Ultimately, a student in the class who was familiar with MMORPG's and paper-and-pen role-playing games was able to teach the class how to play. Whilst helpful in this instance, however, this kind of in-class expertise cannot always be relied on, and should be considered when using such complex games in the classroom.

Concern has also been raised over the negative behavioural effects associated with MMORPG's. Addiction to these games is often perceived as a big problem by the media, but research suggests that this is not necessarily a problem inherent in the games themselves. Chee and Smith (Chee & Smith 2003) discuss how the perceived behaviour associated with MMORPG's differs from typical addiction. They highlight "Community" as "special closeness or bond which unites some persons and differentiates them from other", and suggest that players are only "addicted" to the Community found in MMORPG's in the way that anyone has a need to find an identity in a community where they fit in. A number of real-life cases of alleged MMORPG addiction are presented, indicating that each subject was isolated to begin with, typically with few real-world commitments or responsibilities. The authors suggest that people will always find support networks for their problems, whether they are online or in the real world, and that extreme cases will always arise regardless of the subject's location.

The authors also discuss some of the players' reasons for becoming involved in MMORPG's so intensely. These include the players' fear of "missing something" in the persistent game world while they are away, the degree of social interaction with other players, and the fact that to access the more "interesting" game content found later in the game, players must put in a certain amount of groundwork to achieve the required level of experience. Some players also stated their involvement in MMORPG's to be a method of dealing with real- world problems. However, due to the sensation of being actively, rather than passively involved in the game, the players felt more social and productive, making the experience seem far from a destructive "addiction". The fact that medication typically used to treat addiction had little or no effect on Everquest "addicts" further suggests that the "addiction" perceived in MMORPG players is different to that seen elsewhere. The paper concludes that MMORPG's offer valid communities, and a player's so-called "addiction" to these games can more often than not be attributed to their lack of status or social identity in the real world.

Deviant behaviour in MMORPG's is often highlighted as a problem by players. Lee (Lee 2002) investigates some of the reasons that online play can provoke this kind of behaviour, in both the virtual world and the real world. Anonymity is suggested as a possible cause, as it allows players to deny ownership of their actions. Because their

online behaviour cannot be (easily) traced to who they really are, they are never forced to consider their behaviour within the context of the rest of their lives. As such, they find themselves much freer to express themselves online than they would do in real life. The invisibility associated with online activity has a similar effect. Because players are unable to see physical signs of disapproval from those around them (shaking of the head, frowning, bored expressions), they feel less inhibited in their activity and expression, potentially leading to unwelcome, deviant behaviour.

The synchronous nature of conversation in MMORPG's, like instant messaging, could be partly to blame for upsetting or offensive behaviour. Due to the quick-fire nature of synchronous messaging, conversations using the medium can become shallow, and provoke hasty decision-making. With less time to "think before they speak", players become more likely to say something which could upset others, which they would normally self-censor in a more relaxed conversation. The "level playing field" associated with MMORPG's can also lead to less inhibited behaviour than in the real world. Interacting with authority figures in the real world can dampen players' expression, due to fear of punishment or disapproval. However, in a game where nobody holds any degree of power over anyone else, players become much more inclined to speak and act freely.

Another interesting explanation is the idea that the online experience is in the player's head. The lack of physical, face-to-face cues, combined with text-only output can cause the player to recreate the person they are talking to in their own mind, filling in any gaps with their own memories and attributes of real-life acquaintances. In this way, dialogue between two players essentially becomes an "imaginary" dialogue inside the player's head. When these conversations start to take on these attributes, players can begin turning them into fantasy, where they begin to think, say and do things they would normally suppress. When these actions spill out into the game, they become as real as any other, with potentially upsetting effects.

There is an aspect of off-the-shelf MMORPGs' in particular, however, which makes them unsuitable for for educational repurposing: their completely closed nature. Due to the delicate issues of gameplay balance and in-game economy, user development opportunities for these games are virtually non-existent. While some games like "Star Wars Galaxies" allow for a degree of user-positioned content, the buildings and scenery placed in these circumstances are typically drawn from a stock selection. In this way, it is used mainly to establish user- created settlements of pre-defined structures, rather than to allow user-generated gameplay mechanisms. This could restrict the use of existing MMORPG's as educational tools, as there is very little scope to redefine their content and gameplay if either isn't entirely suitable for the required educational experience.

## 4.8 Second Life

Linden Labs' Multi-User Virtual Environment "Second Life"[2] is gaining popularity, with over six million registered users[3] – doubling in number between January 2007 and May 2007 (Boulos, Hetherington & Wheeler 2007). Several important features have contributed to this popularity, including a lack of subscription fee and the game world's reliance on user-generated content. These features are particularly attractive to educators, as both would be beneficial when using Second Life for massively- multiplayer educational purposes. The ability to develop their own in-game content allows educators to create exactly what is required to realise their learning goals, rather than trying to re-appropriate an existing product which may not be entirely suitable for their needs. Whilst developers must pay a monthly "ground rate" for the virtual "land" on which this content is developed, the results can be made available for free to other users. Free content combined with free access to the multi-user world itself makes it much easier for a class of 30 students to access the new material than if the typical monthly subscriptions of MMORPG's were in place.

Whilst this world of free-to-play, user-created content might sound like the perfect multi-user solution to a number of educational requirements, Second Life is not without its problems. Firstly, it is a Multi-User Virtual Environment – at no stage does it claim to be a *game*. The world offers all of the social and exploratory attributes of MMORPG's, but essentially none of the gameplay attributes which make them so educationally useful. Second Life offers no quests or explicit goals, and as such there is no difficulty balance – or rather, there is no difficulty *to* balance. In addition, there is no "levelling up" in second life: apart from altering their avatar's appearance, the player is unable to noticeably improve themselves within the virtual world, losing out on the social obligation to advance that is found in most MMORPG's. In addition, the concept of restricting player access to certain areas until they reach a certain level is lost – in Second Life, an area is generally free to access, or restricted, regardless of how experienced the world assumes the player to be.

In addition, while the 3D virtual world seems initially immersive, issues of performance can soon destroy any feelings of immersion. Whilst Second Life will run on low-end machines, players can expect lagging controls and short draw distances when playing on anything but the fastest machine and network connection. This may have been overlooked by today's educators, raised on the 2D computer graphics of the 70's and 80's, but whether it will be able to impress students raised on high-spec PC's and next-generation games consoles remains to be seen. Another problem exists when using Second Life with under-18 students. To avoid the potential problems of allowing teenagers and adults to mingle in a single online world, 13 to 17-year olds are confined to their own version of the

[2] http://secondlife.com/

[3] According to the statistics shown by Linden Labs at http://secondlife.com/whatis/economy_stats.php

game, "Teen Second Life". In theory, adults are allowed to enter the world for "special educational projects"[4], but in practice, educators have faced problems when trying to gain access to Teen Second Life for development purposes.

In spite of these problems, some educational solutions have been developed in Second Life. The Sloodle[5] project aims to integrate the Open Source Moodle LMS with Second Life, making an educator's Moodle resources available within Second Life's 3D world (Kemp & Livingstone 2006). Whilst successful in offering these resources, the project makes no attempt to recapture the affordances lost through Second Life's lack of inherent gameplay. In theory, educators could create small games as Moodle resources which could then be accessed via Sloodle and Second Life. However, this approach would surely leave a lot to be desired in the face of MMORPG's finely balanced, well-defined (and rewarded), immersive quests.

## 4.9 Conclusion

In this chapter, we highlighted the particular educational benefits of the MMORPG genre. The tasks within these games can promote a scientific way of thinking, both individually and as a community. The way in which these communities work together appears to be appropriate to the kind of group work typically employed in a modern classroom. Motivation and "Flow" are maintained through clear goals, appropriately difficult challenges and continual rewards – both social and functional.

These games are not without their potential drawbacks. Antisocial behaviour and addiction are cited as two of the main problems amongst MMORPG players. However, research has shown that while these behaviours do exist, the games themselves are not necessarily entirely to blame. Furthermore, by placing these games in a classroom, instructor-led scenario, the impact of these behaviours could be reduced. We have also seen that while Second Life is an enticing prospect to educators, it is missing many of the benefits offered by more established MMORPGs. As such, its educational benefit beyond that of a more traditional learning environment remains to be seen.

[4] http://teen.secondlife.com/whatis
[5] http:// www.sloodle.com

# Chapter 5

# Are Minigames the Answer?

One recent peak of interest focuses on the area of minigames - short, self-contained games, usually based around a single principle, be it ludic or pedagogical. Prensky suggests that while educational mini-games can be "good for providing motivation to practice particular focused skills" , they are ultimately "trivial", and "lack the breadth and depth necessary" to educate. (Prensky 2005).

However, the complexity of using games to teach has been cited as a hindrance in their uptake (Becker & Jacobsen 2005), so these flexible, lightweight games could be just what today's educators are looking for. But how useful can these games be in an educational context? Are they deep enough to illustrate the full pedagogical content of a given area, or as Prensky suggests, are they too shallow to offer any educational value?

Table 2.1 suggests that the most important features of an educational resource are the ability for learners to explore contextually relevant environments, learner-instructor conversation, the opportunity for learners to integrate new knowledge with existing models, and the option for instructors to offer feedback on student activities. With this list in mind, the suitability of mini-games as educational resources can be assessed.

## 5.1 Method

In order to evaluate the different educational qualities offered by mini-games, 26 different games were selected from the "BBC Schools"[1] website. These games were selected across various topics, including history, science, languages and mathematics. In addition, games were selected from a range of different types, from simple number puzzles, to intricate re-enactments of historic battles.

[1] http://www.bbc.co.uk/schools/

As the games were played through to completion (in some cases, multiple times), careful attention was paid to how well they met the requirements shown in Table 2.1. By assessing how many of these requirements were met by each game, and how well each is met, an indication of how well mini-games could work in an educational context was provided – the more requirements they successfully met, the more useful they should be.

## 5.2 Results

In carrying out the investigation, many of the games exhibited similar strengths and weaknesses. To avoid excessive repetition, only the more interesting features unique to each game have been presented in this section. A complete list of the successes and failings of each game can be found in the appendices of this thesis, in Table A.2.

### 5.2.1 Death in Rome

This game surrounds the investigation of a mysterious murder in ancient Rome. The game is presented in a classic "point-and-click" adventure style: a detailed, static backdrop with various "hot-spots" scattered around it. These spots relate to objects of interest within the scene, allowing the player to pick up, use or further investigate them with a click of the mouse. This manner of investigation, combined with the murder-mystery scenario could work well in provoking curiosity in the player.

The way in which different clues "cross-reference" is also an interesting way of helping players to assimilate new knowledge into what they already know. Also, despite its two- dimensional nature, the environment and its contents are still "explorable", with contextually relevant artwork helping players to immerse themselves in the information provided.

The player's goals are set out clearly from the offset: find sufficient clues within a specific time limit, in order to make a confident deduction about the cause of death. With these goals established, the player is able to discover new knowledge within the scene. In addition to the information found by clicking on the objects, the player is able to ask "experts" further questions. These "experts" are either historians, or Roman citizens, who provide supplementary information on in-game items at the player's request.

This mechanism is useful in two ways. Firstly, it allows the full pedagogical meaning of the objects to be expressed, without overwhelming the player by showing it all at once on the main screen. It also means that the player is never forced to read the additional information - they only need only look at it when they need to fill gaps in their knowledge. This provides an interesting balance between boredom and frustration, with help on offer for when it is truly needed.


FIGURE 5.1: The murder scene in "Death In Rome" (taken from BBC Schools)

### 5.2.2 Pyramid Challenge

Here, the player is given control of the arrangements surrounding the construction of an ancient Egyptian pyramid. Everything from the choice of site, to the materials used, to the types of workforce is left in the player's hands.

On the surface, the game seems as well designed as Death in Rome, with detailed, relevant artwork, and a reasonably well defined long-term goal ("build a pyramid"). However, on actually playing the game, we see that many of the qualities found in Death in Rome are missing from Pyramid Challenge.

The first problem can be seen in the lack of new knowledge presented to the player. Where Death in Rome essentially had one question ("who was the murderer?") and a wealth of new information, Pyramid Challenge asks far more questions without providing anywhere near as much information. Where new information is given, it is often insufficient to allow the player to make informed choices. For example, when selecting a site for pyramid construction, details of the site's location, terrain and convenience are given. However, no clues are given as to how these details relate to the plight of a pyramid builder, making it difficult for the player to contextualise the new information efficiently.

There is also no real incentive for the player to integrate this limited new knowledge into their existing models - for example, once a site has been chosen, it makes no difference


FIGURE 5.2: Choosing a building site in "Pyramid Challenge" (taken from BBC Schools)

to what size of pyramid the player builds, so why should they bother to factor the site location into a persistent mental model?

Curiosity and immersion are also lacking from the game's design. Where the player was able to explore a room in Death in Rome, in this game, the player simply responds to a series of question prompts, as and when they appear. There is no room for exploration, no world in which to be immersed.

A short, arcade-style boat-driving section is included in the game, possibly as motivation ("play the game, have fun driving a boat"), possibly as a reward ("you've completed this much of the game, now have fun driving a boat"). Whilst this may seem like a good idea, the way in which it offers no pedagogical benefits can actually make it act like more of a hindrance. By making such a detached section of the game seem like the "fun part", it infers that the rest of the game (where any actual learning takes place) is the boring part, completely missing the point of using games to benefit education.

### 5.2.3 The Battle of Waterloo

As the title suggests, this game aims to simulate the actions of the Battle of Waterloo. Viewing the battlefield from an isometric, overhead perspective, the game works in a turn-based fashion with actions controlled by player responses to a series of questions.


FIGURE 5.3: Troop deployment in "The Battle of Waterloo" (taken from BBC Schools)

The game demonstrates a good amount of new knowledge at the start of the game, with information regarding the army's campaign history and tactics being offered to the player. Whilst rich in its detail, the point at which it is offered could be better - once the game is started, the player cannot go back and look at the information, forcing them to remember it all if they want to succeed.

The game mechanic appears poor in its provocation of curiosity, as well as in its balance of difficulty. Because the player is always presented with two tactical choices – one of them right, one of them wrong – they find themselves reluctant to experiment: by trying something different to the correct answer, they are guaranteed to lose. And because their only input into the games outcome is through this choice, there is very little room to balance the game - either the player knows the answer, and they win, or they don't know the answer, and they lose.

However, once the game is completed for the first time, curiosity starts to build. What if the player were to go back and try a different tactical option? What if they were to fight the battle from the other side – and still win? In replaying the game multiple times and in different ways, the player can learn more about how military tactics of the era worked, helping them to contextualise the actual events of the real battle.

### 5.2.4 Blue Planet Challenge: Alien Planet

This game's main success can be seen in its explorable underwater environment. This setting is perfect for provoking player curiosity, as well as providing players with a contextually-relevant method of satisfying it. This all helps to increase player immersion, improving the player's flow state and motivating them to learn more. However, the way in which information about the creatures in the game is displayed (pop-up text boxes) disturbs this immersion quite badly. This method does allow the full pedagogical background of the creatures to be expressed, creating a richer learning experience.

Player feedback is only offered at the end of the game, which creates problems in keeping players motivated. Because players only find out whether they have been playing well or not at the end of the game, they could find themselves unwilling to progress during the game itself, without having their actions validated first. This could lead to a very frustrating experience, limiting the amount that the player is able to learn.

### 5.2.5 Battle of the Atlantic

Because this game teaches the player all they need to know at the beginning, frustrating situations can arise, where the players remembers learning a particular detail, but has no way to go back and refer to it. The military academy scenario provides an excellent contextually relevant environment for learning, with the battle itself providing a similar stage for applying the newly acquired knowledge.

The sea battle is useful enough while it lasts, but with only one, randomly generated scenario per play-through, the game might not offer a broad enough context for players to experience all of their new knowledge. To apply more of this knowledge, players will have to embark of further play-throughs, generating an element of curiosity. Thankfully, the players can skip the academy section during future plays, offering a kind of difficulty balance for those who already know what to do. Whilst balanced for over-experienced players, however, under-experienced ones receive no further help once leaving the academy stage, potentially leading to frustrating times.

### 5.2.6 Spanish News for Becks

This is an awful example of an educational game, offering a single multiple choice question with three single-word answers. This creates a completely unexplorable environment, and offers no rewards for experimentation (selecting one of the two incorrect answers merely results in a "wrong answer" sound).

Because the question takes the form of a snappy newspaper headline, there is no context for the player's answer, making it impossible for them to integrate what they have learned

into their existing knowledge. Some difficulty balance is provided by offering the english translations of the possible answers, but as any of them would be valid grammatically, the game's lack of context makes this rather unhelpful.

### 5.2.7 Diver's Quest

Taking the form of ten yes/no questions, this game offers no real new knowledge until each question is actually answered. With fairly obscure questions and no supporting pedagogical information, the game is essentially won on guess-work alone, resulting in no use of acquired knowledge whatsoever. The game ends after a single incorrect answer, showing a lack of balance for inexperienced players. With no real rewards for answering a question or completing the game, there is no real motivation for players to finish the game. In addition, the questions are the same each time, offering no incentives for future replay or experimentation.

### 5.2.8 "Early Church" Tic-Tac-Toe

Another multiple choice game where knowledge is only really acquired through feedback once the questions have been answered. Again, there is no supporting pedagogical material in the game, and no adaptive difficulty mechanisms, making the game frustratingly hard. The gameplay environment (a noughts-and-crosses board) is completely contextually irrelevant to the game content, making it difficult to fully integrate new knowledge into the player's existing knowledge base.

No rewards are offered at all, and there is very little incentive to replay the game, other than as a mechanism for eliminating wrong answers via trial-and-error. However, even this tactic proves fruitless, as the lack of context makes it almost impossible to remember which answers the player has already given during previous play-throughs.

### 5.2.9 Guy Fawkes

One of the biggest problems with this game is the strictness of the time limit. The walking animation of the player's avatar takes up a large amount of game time, resulting in an incredibly frustrating experience. After several attempts, I never once managed to complete the game, running out of time on every occasion. As new information is only revealed on successfully completing questions, this resulted in a less than optimal learning experience.

The question-marked rooms generate a slight element of curiosity, but exploration is lacking as the whole map is displayed from the start. As with so many of the games

reviewed, the game is based largely around assessment, and offers no real instruction other than through the player's answer to the questions.

### 5.2.10 History Bluff

This game appears to provoke curiosity, as the "bluff" answers all seem feasible. However, as no explanations are given for these answers, the player soon learns that their curiosity will go unrewarded, removing this motivational element entirely. No rewards are given for answering the questions correctly, so another point of motivation is lacking.

### 5.2.11 Historical Targets

While based around the premise of archery, this game is still just another multiple choice quiz. As a result, no exploration, immersion or curiosity is present – the player just answers a series of questions. The game does offer feedback on a per-question basis, which is better than the effort made by previous games. It allows players to understand why they were wrong, allowing them to make more informed decisions on future play-throughs, rather than just remembering which options were incorrect. However, as the game offers no real rewards at all, it is unlikely to motivate future play-throughs.

### 5.2.12 Journey to the Deep

Another underwater game which creates an explorable environment, providing a contextually relevant method of exploring it. This setting encourages immersion in the game-world, freeing the player from external distractions and therefore increasing in-game motivation. Whilst they detract from the immersion somewhat, the textual descriptions of the creatures encountered offer rich pedagogical information. This information is used later in the game to help decide which creature to morph into, offering the player an opportunity to contextualise the information they have just learned.

### 5.2.13 Ice Breaker

This game establishes clear goals from the start: the player is here to take probe readings and photograph animals. This not only prevents frustration related to unclear goals, but also adds an element of immersion, as the player is performing the same tasks as they might do on a real ship. New knowledge is presented to the player through charts, maps, instrumental readings and advice from fellow scientists. Again, this helps with immersion, as the information is presented as it would be in a real-life scenario.

The player is encouraged to contextualise this information when the game asks questions which require them to read, understand and cross-reference the the data they are given. A small amount of curiosity is also provoked, as the animals in this game are initially represented as silhouettes. In all the other games, the creatures have been clearly visible from the start, with "Ice Breaker" asking players to "photograph" them before finding out what they actually are.

### 5.2.14 Life On The Edge

In this game, players are asked to collect as much information as they think they will require, before answering a series of questions related to the new material. Whilst appearing to act as some kind of adaptive balancing mechanism (where players are only asked to research as much as they need to), it doesn't really work, as the player has no idea what questions will be asked. As a result, the player has no idea how much information they will need to learn, and so will have to read it all to make sure all possible topics are covered.

This game also makes use of the common gameplay mechanism of player "lives", where a player is only allowed to make a certain number of mistakes before they are prevented from continuing. But does this really help in a learning situation? If a player loses all of their lives, it is presumably because they didn't know enough about the topic to progress. So by ending the game and forcing the player back to the beginning, the player may have to repeat sections of the game that they fully understood, just to revise the sections they didn't. A much better, adaptive mechanic might be to send a player back to the "learning" section of the game for which they failed the "assessment" section. In this way, they will be able to reinforce their knowledge in the required areas, without enduring the boredom of repeating all the sections before it.

### 5.2.15 Dive To The Abyss

The goals of this game are set out clearly from the start, along with a time limit. This helps in two ways: it helps to motivate the player, as they have to "beat the clock" in order to win the game; and it helps with the clarity of goal provision, as a suitably calibrated time limit gives a good estimate of how long the task should take. Again, exploration is implemented well through an underwater mini-sub mechanism, helping to immerse the player.

The objectives themselves ask the player to satisfy a number of criteria offered by different underwater creatures. Because each creature may possess several of the characteristics, the player is forced to cross-reference the creatures in order to find a suitable combination. This helps the user to reinforce the knowledge they have learned. In

addition, subsequent replays of the game offer different, randomly selected objectives, offering further opportunity for information contextualisation than an identical game where answers could simply be remembered from previous attempts.

### 5.2.16 Open Ocean

Presented as a race between a sea creature and a fishing boat, "Open Ocean" is essentially another multiple choice quiz. The main problem with the game is that it offers no useful supporting material. As a result, the questions are often impossible to answer without using guess-work. Some new knowledge is offered whenever the creature "evolves" (after answering successfully) or the ship "upgrades" (after answering incorrectly), but as this information almost never relates to the questions asked, it isn't very helpful.

It could be argued that the "race" mechanism is supposed to promote competition, and motivate the player to do better. However, as the player's success is based entirely on their ability to answer multiple choice questions, they have no real ability to indulge this competition. Either they know the answer or they don't, and as such, there is ultimately nothing that they can be motivated to do.

### 5.2.17 Webs Of Life

The initial levels of this game provide a useful difficulty balance: if the player already knows about the creatures involved, they can simply "find" them and move on; if, however, they need to learn more about them, they can spend as long as they like reading the supplementary information for each discovered creature before moving on.

The game also exhibits a sensible increase in complexity as the player progresses. Starting with individual creatures, the player is then asked to understand simple food chains, more complex food webs, and finally the implications of changing different elements of the food web. This helps to balance the difficulty of the game, as the layer will be unable to reach a point further in the game before they have shown an understanding of the structures which feature in it.

In addition, should a player provide an incorrect answer, the game will give them a number of chances and hints before revealing the correct answer. This acts as a kind of adaptive difficulty mechanism, providing just enough help for the player to progress, without boring them with information they already know.

### 5.2.18 California Coast

Another aquatic-themed game, incorporating various gameplay devices found in the other, similar games. However, in this game, they aren't always implemented as successfully. Again, undersea exploration is used to promote curiosity, but doesn't work as well as it should. Because everything that can be clicked on is important, the game quickly becomes an exercise in "find all the hotspots" rather than "find the objects of actual importance".

As with many of the multiple choice quizzes reviewed so far, the questions relating to food webs offer no new information, leading to a very frustrating time when essentially having to guess the answers. In addition, the incremental hints provided in "Webs Of Life" are missing here, replaced by unhelpful error messages. These messages continue to appear for every wrong answer, until the right answer is chosen, allowing the game to be completed using purely iterative techniques.

### 5.2.19 Nervous System Game

This game asks the player to place a series of different body parts on an outline of the human body, before connecting them to the correct section of the body's nervous system. Should the player need any help, a separate page can be opened, detailing all the information required to successfully complete the game. However, therein lies the problem: the page contains **all** the information needed. This makes finding the specific piece of information required quite a laborious task. And considering the player can simply try each possible answer until the right one is found, with no apparent penalty, it is quite unlikely that a player would actually go to the trouble of finding the information in this way.

The feedback offered throughout the game is often rather unhelpful. If the player joins an organ to the wrong part of the nervous system, rather than an flagging the mistake, or offering hints toward the correct answer, the game simply does nothing. This makes for a very frustrating experience, as the player can feel unsure as to whether they got the answer wrong, or simply clicked in the wrong place. The post-game feedback is also too vague, stating how many questions were answered incorrectly, but not specifically which questions. This makes it difficult for a player to identify gaps in their knowledge, in turn making it hard to know which

### 5.2.20 The Lost Army of Fu Shi

Taking the form of a puzzles game, "The Lost Army of Fu Shi" is a good example of a game being used to motivate learning. At set points throughout the game, the player

is asked to answer multiple choice questions. The quicker the player finds the correct answer, the more extra time is given for the player to continue the game. As the game is over when the time runs out, the player is motivated to answer quickly and correctly in order to maximise their play time.

In this way, the game acts more as an assessment, rather than a learning experience. Because the player is encouraged to answer quickly, they are discouraged from spending time looking up information to inform their decision. If the player doesn't already know the answers, this could become a very frustrating experience, with the game ending very quickly. Perhaps a better way of rewarding the player would be to reduce the amount of bonus time given per incorrect answer, encouraging the player to give correct answers, rather than quick ones.

There is also a potential issue with the degree of immersion the game offers. Puzzle games are often associated with a "flow zone" style of play, where players become immersed in the game, ignoring external distractions. Each multiple choice question only has three options, whereas each step of the puzzle game has sixty-six. This suggests that from a "flow-zone" perspective, decisions on the game board will become much more engaging (and in turn, immersive) than the decisions in the question part of the game. Like the boat driving section of "Pyramid Challenge", this could have the detrimental effect of making the educational part seem like the "boring bit", with players playing in spite of the educational material rather than because of it.

### 5.2.21 Destination Death

Set in a French airport, this adventure game involves mainly conversation and exploration. Realised via a consistent, stylised backdrop and set of characters, "Destination Death" becomes a very immersive experience. The mysterious plot and cliffhanger endings are good at provoking curiosity, encouraging self-motivated learning.

The conversations with in-game characters are effective at contextualising the language the player is using. If the player gives a wrong answer, the character will act suitably confused, helping the player understand the impact their actions would have in the real world. The mixture of spoken and written language help create a rich learning experience, again giving the player a clearer idea of how the language will actually be used in different ways.

On the negative side, the questions early in the game are often far too easy. While three difficulty levels are offered, the correct answer is often obvious, even on the hardest setting. The incorrect answers are typically completely irrelevant and much shorter than the correct answer, making it easy to spot with only a basic grasp of the language. However, later in the game, the task gets much harder, very quickly. In later levels, different answers are only distinguished by the tenses used, or similar-sounding but

differently- spelled words. This learning curve seems somewhat sharp, and could be frustrating to players initially comfortable with the game's early difficulty.

### 5.2.22 Spherox

A race-against-the-clock maze game, Spherox uses some good examples of game design, but falls short of fulfilling many educational requirements. The game begins with an overview of the whole game level, showing the start point, the goal and the pick-up objects along the way. This does a very good job of defining the player's objectives, resulting in minimal gameplay-related frustration.

The multi-choice quiz element of the game creates a rather shallow learning experience, making it difficult for the player to contextualise what they are learning. The in-game feedback is also of low quality, giving only a total number of questions answered correctly. Again, this makes it difficult for the player to understand which areas of the subject need further work, limiting their ability to improve their understanding.

The concept of in-game "cheats" creates potential problems, as it allows players to replace subject understanding with gaming skill. As the player collects "cheat" objects in the game world, they are given the opportunity to use each one avoid a question they are stuck on. Whilst this may allow a player to avoid the frustration of a difficult question, it also removes the benefits of answering it, as the player is never shown the correct answer.

### 5.2.23 World War When?

The main screen of this game is very intimidating, presenting the player with a series of events and an empty, six-year timeline. No surrounding hints or starting points are offered, making it impossible for someone unfamiliar with the subject to even begin the game without using pure guess-work.

Once the player does begin the game, matching events to their corresponding month and year, some assistance is offered. Two wrong answers can be given per event, before the correct answer is given to the player, and adaptive hints are offered after each incorrect attempt: if the player gets the year wrong, another year is suggested; if the right year, but wrong month are chosen, the game suggests which time of year the event took place in. This is useful, as it still provides a challenge for the player, whilst removing layers of frustration if they appear to be stuck.

The user feedback is also quite helpful to the player. As the player progresses, the game keeps track of which questions were answered correctly or incorrectly, helping the player to see which areas need more work. However, this information is lost as soon as the final

question is answered, potentially causing the player to lose this information before they get a chance to use it.

### 5.2.24 The Apostrophes Game

This game begins well, clearly defining the player's goals. A series of phrases are presented (e.g. "I cannot"), and the player is asked to shorten them using an apostrophe (in this case, to "I can't"). Three different time limits can be chosen, giving the player a degree of control over the game difficulty. The time limits also serve as a suggestion for how long the player should take to complete the game, reducing another layer of frustration.

The feedback is initially quite poor, simply telling the player whether the answer they provide is right or wrong. However, the post- game feedback is excellent, going through the player's answers, question by question, showing the expected answer along with the one the player actually gave. This allows the player to see exactly where and how they went wrong, giving them a clearer understanding of where improvements in their knowledge need to be made.

The lack of context could pose problems in players' understanding. Because the phrases are presented in isolation, rather than in an example sentence, players may find trouble using them in context later on. Perhaps a better idea would be to present a full sentence incorporating the existing phrase, allowing players to see exactly how the phrase should be used.

### 5.2.25 The Termites Game

This game claims to teach "mammalian eating habits", but ultimately teaches very little. Presented as an arcade-style game, the player has to click on termites to eat them as they emerge from a termite-hill. The only "mammalian eating habit" the game mentions, is that soldier ants have to be eaten quickly before they sting you, but it remains unclear as to whether this is true in real life, or simply devised as a game mechanism. Playing the game further does nothing to increase the player's understanding – once the single fact has been understood, the game offers nothing more.

Some of the gameplay mechanisms offered by the game are useful in their own right. The high-score table is traditionally good at motivating players through competition, and the game's single, simple goal means that confusion is unlikely. Arcade games are also traditionally good at keeping players in the "flow zone", encouraging self-motivated participation. However, in a game with so little educational content to offer, keeping the player motivated will have little effect on the amount they stand to learn.

### 5.2.26 Memory Maze

Another game with little educational value, "Memory Maze" begins by showing a grid containing an animal, its food, some predators and a mate. After showing this information, however, the game becomes a simple memory test, as the player has to guide the animal to its food and mate, avoiding the predators. As with "The Termites Game", the player stands to learn nothing new by playing the game any further.

Again, goal definition is clear, and the time limit serves to motivate the player. However, they only become motivated to play the game faster, and not to learn anything new. In addition, the goal definition states that they will lose points for taking an less-than-optimal path to the maze exit. This stifles the player's curiosity, limiting the likelihood of self-motivated learning.

## 5.3 Analysis

TABLE 5.1: The number of games satisfying each of the criteria

| **Criterion** | **Number of Games** |
|---|---|
| Allow conversation between instructor and learner | 0 |
| Demonstrate new knowledge to the learner | 20 |
| Allow instructors to establish explorable environments that are contextually relevant | 2 |
| Provide opportunity for learners to explore these worlds | 7 |
| Allow instructors to provide feedback on the learners' actions | 3 |
| Provide a customisable balance between boredom and frustration | 10 |
| Provide the learner with explicit goals | 23 |
| Allow the learner to integrate new information with their existing knowledge | 9 |
| Motivate the learner by provoking curiosity | 8 |
| Promote a sense of immersion within the environment, free of distractions outside the environment's context | 5 |
| Offer rewards when goals are achieved successfully | 4 |
| Unite a number of learning resources in a single environment | 2 |
| Support blended and full online learning | 0 |
| Allow the full pedagogical meaning of data to be expressed | 14 |
| Compatibility with different standards | 1 |

The observations made while playing these games were used to compile Table 5.1, highlighting how many games satisfied each of the original requirements. These tables,

backed up by some of the more specific details of the games, allow me to make some more generalised observations on how well minigames cater to an educator's potential needs.

Very few of the games offered detailed enough feedback to effectively show instructors how well their students were doing. The games which did provide feedback typically only gave the number of correct answers, or even whether the player had simply failed or succeeded in their task. On the occasions where games offered detailed information, it was usually presented in an impractical way that was difficult to record, or was easily skipped and lost forever. In addition, no opportunity for conversation was provided whatsoever. This meant that even if sufficient feedback were given, the instructor would be unable to offer their own thoughts to the student within the game itself. However, in a game as short as those reviewed, this may not be such an issue, as feedback given after the game could still be current enough for the student to reflect effectively on what they had just done.

Not many of the games offered any opportunity for exploration or deep immersion, even though it is perfectly possible in a minigame context. The games which did foster immersion and exploration did so with fairly small, yet richly-defined areas – "Death in Rome", for example, offered some of the deepest immersion and exploration, yet was set in a single room of a house. In addition, none of the games allowed instructors to create the environments themselves, limiting the scope and reusability of each game. As the explorable areas are effectively two-dimensional images covered in hotspots, creating these environments should theoretically be quite easy. In addition, this editing process could incorporate an element of standard-compliance, with game "levels" easily interchangeable between users, in much the same way as online, multiplayer games. This standard-compliance was lacking from every game tested, with each one being entirely self-contained. When so many games were based around multiple-choice questions, the ability to use each game with any set of QTI-compatible questions could be a sensible way to extend their useful life, without much extra work from the instructor.

With a few exceptions, goal provision is satisfactory, although this is often due to the relative simplicity of the games' goals, rather than the detail in which they are provided. Around half of the games offered a dynamic adjustment in difficulty, typically in the form of auxiliary information, used to better inform the player's decisions. Around half of the remaining games offered a static adjustment in difficulty (for example, by choosing an "easy", "medium" or "hard" difficulty setting), with the rest being far too easy, or inexplicably hard. It might be unreasonable to expect dynamic adaptive difficulty adjustment in such short games, as the mechanisms used to make it happen typically need extended periods of play before they "learn" how to help the player. But the extra information – offered only when the player needs it – seems a good way of helping players in need, without hassling those who don't need assistance.

Only a few of the games provoked any kind of curiosity, with the majority being linear and restrictive. These games were all of the "adventure" style, with an open area to be explored by the player: a Roman villa in "Death in Rome", or any of the underwater environments from the sea exploration games. This suggests that certain genres of game offer some gameplay affordances better than others, and certainly warrants further investigation.

The games rarely offered specific support for blended learning. While many of the games would have suited blended learning well (due to the sparse nature of information they themselves provide), none of them gave any explicit indication that blended learning should be used. Simple cues to suggest additional reading, group work or classroom discussion could easily be implemented into these games, along with mechanisms to pause the game until the player is ready to continue.

In the instances where the information provided by the games was sufficient, there was typically too strong a reliance on text. Games have access to a wide range of media, and yet information was almost given via text explanations. In addition, the information was often given in an unhelpful manner, such as once at the start of the game, or in a large, unorganised block of text. By utilising the full range of media available to them, and pacing this information more sensibly, players should be able to learn more intuitively, without becoming bored by too much information, or frustrated by too little.

Several of the criteria were not met by the games, due to their brevity. The opportunity for the player to integrate what they had learned into their persistent contextual model rarely arose, simply because the game was too short to require them to recall any previous information. In longer games, tasks will be given to the player which require them to call on what they have learned in a previous section of the game, strengthening their understanding of it. But in a minigame, often lasting only a few minutes, these tasks simply weren't there. In addition, the rewards offered by the games were never "interesting", in the sense that they had an effect within the game. Again, this was due to the games not being long enough. Players are typically rewarded with money, weapons or power in a longer game, which can then be used within the game itself to enhance their gameplay experience. But in minigames, such rewards would be trivial, as there is no opportunity for the player to use them.

One way to overcome these problems might be to collect a series of minigames together into a compendium, where the information learned in one game will be called upon in another. This would allow the player to reinforce their understanding of one game's material, without having to make the original game longer. Similarly, by making the rewards have an effect across the different games, the original game can be kept brief, while still allowing the player to feel that their rewards actually matter.

## 5.4 Conclusions

The results of the investigation show that minigames potentially have a lot to offer. However, all of the games studied were lacking in at least one of the areas identified as important to educational gameplay. But how much of a problem is this really likely to be? Is it vitally important that every game meets every one of the identified requirements in order to be successful? Does every requirement need to be met in order for the game to be fun?

The initial exploration of gameplay mechanics suggests that different games and gameplay styles are likely to offer different educational affordances. So, is it genuinely a problem if a game fails to offer some of the requirements that are not typical of its genre? The next stage will be to explore some successful commercial games from different gaming genres, in order to evaluate which affordances they meet. In doing so, an initial picture can be built, identifying which affordances are likely to be offered by games of a certain genre, and which ones we can afford to lose.

# Chapter 6

# The Affordances of Different Gaming Genres

Despite the ongoing research into educationally beneficial computer games, educators are often still reluctant to include computer gaming in their teaching activities. This could be due to a number of factors, including prohibitive start-up costs (regarding both time and money), weak institutional IT support, inflexible gameplay duration, or even the negative social stereotyping of modern video games (Becker & Jacobsen 2005) (Delwiche 2003). Discussion with educators at the 2007 ALT-C conference exposed another of these factors: the sheer variety of games available, coupled with lack of useful information on exactly how appropriate they are to the subjects they are trying to teach.

This lack of useful description extends to the research community. An oversight made by many of the fields authors (pointed out by Kurt Squire (Squire 2002) (Squire 2005)), is the classification of different gaming genres  or rather the lack of it. The prominent papers in the field discuss the different affordances offered by computer and video games to education, as if all genres of game can offer them with equal success. As the world of computer gaming has evolved tremendously since its beginnings, the diverse characteristics of modern games suggest that this is not the case. To explore this idea, an investigation was carried out into twelve different games, taken from four different genres, where their effectiveness at satisfying certain educational requirements was assessed.

## 6.1 Existing Research

In his paper, "Changing The Game: When Video Games Enter the Classroom" (Squire 2005), Kurt Squire discusses several potential benefits to education, offered by video games. While he himself uses the popular strategy game"Civilization III" as an example, he points out that it may not be the game for everyone, and that educators should

expect different gameplay experiences from games of different genres. However, as these different experiences are not discussed in further detail, a gap is left for our investigation.

Jan G. Hogle (Hogle 1996) identifies several gaming genres, as well as some educational affordances offered by video games. However, the two are never mapped to one another, and the proposed affordances are presented in a genre agnostic fashion. As such, the paper offers no real elaboration on the inter-genre differences highlighted by Squire.

Alan Amory et al. attempt to analyse the differences between gaming genres, but take a different approach to ours (Amory 1999). Taking one game from each of four genres ("strategy", "adventure", "simulation" and a first-person shooter labeled as a "shoot-em-up"), a group of 19 users were asked to play the games, and evaluate how well they satisfy certain qualities. While the results show that there are differences between the gaming genres, there doesn't appear to be any sound rationale behind the selection of these qualities. In addition, only one game was taken from each of the chosen genres, failing to show how different games within a genre can still offer very different gameplay experiences.

There are other papers which appear to make claims about what games will and won't offer the user, without any acknowledgement of the differences between genres. Fabricatore (Fabricatore 2000) suggests an "interactive cycle", consisting of "analytical capabilities", "strategic thinking", "psychomotor skills" and "enrichment of players knowledge". Yet, for example, turn-based strategy games require negligible psychomotor skills, and classic, reaction-based "shoot-em-ups" are unlikely to enrich the players knowledge base to any noticeable degree. The elements of the cycle are potentially valid, but not universally so.

Paras and Bizzocchi (Paras & Bizzocchi 2005) discuss features of gaming, including "reflection", where the player considers their past in-game actions to inform their actions in the future. However, certain games such as the kind of mini-games found prominently on the Web have been shown as too short to offer opportunity for reflection. So again, while the claim that games offer opportunities for reflection is potentially true, it will not be in every case.

## 6.2 Method

In order to identify some of the differences between gaming genres, a set of these genres had to be chosen, followed by a number of games from each one. The genres selected are by no means exhaustive, but represent a large proportion of games available today, and are different enough from one another to warrant distinction. The genres selected were:

- "First-Person Shooter" (a popular, combat-heavy genre where the player views the game from the perspective of the main character)
- "RPG Adventure" (a hybrid genre focusing on character development, exploration and problem solving)
- "Puzzle" (where the player has to solve increasingly more intricate puzzles, usually relying on a single, core mechanism)
- "Strategy" (where resource management, planning and strategic deployment are the main player requirements)

Three games were selected and played from each of the three genres. Special attention was given to identifying features from the requirement set developed in Chapter 2, detailing useful requirements for an educational game.

## 6.3 Results

Here, some of the more pertinent features demonstrated by the games are discussed, followed by a table detailing the complete observations from all of the games and genres.

### 6.3.1 First-Person Shooters

The games chosen to represent this genre were:

- "Half Life 2" (A story-driven game, blending combat, exploration and physics-based puzzle solving)
- "Team Fortress 2" (A stylised, online team combat game, featuring nine very different roles)
- "Battlefield 2" (an online modern war game, with a strong focus on teamwork)

All three of the games allow players to talk amongst themselves using text chat or voice chat. Messages can be sent to all players in the game, or just to players on the users team. In addition, Battlefield 2 distinguishes smaller groups of players, called squads and the opportunity for in-squad chat is also provided. In addition, the game identifies a separate role of the commander, who has access to more complex troop communications. These different communication options could cater well to individual or group-based learning activities, with the commander role being potentially useful for instructors wishing to join in the game at the same time as their students.

New knowledge is presented in all three games, in different ways (non-player character interactions, documents within the game world, explicit text pop-ups). An additional feature of Battlefield 2 allows players to flag enemy positions on the radar when they are encountered in-game. This type of presentation could be interesting in an educational setting, allowing learners to teach each other whenever they find something out, rather than relying on the directions of their instructor.

Both Half Life 2 and Team Fortress 2 offer tools for users to create game levels, affording the creation of in-game environments. However, this requires skills in scripting, 3D modeling and texture design, not to mention the game design skills required to create a balanced level. So whilst possible, it is not necessarily feasible.

All three games promote exploration differently. The story-driven nature of Half Life 2 means that the game progresses in a somewhat linear way. As such, the exploration is afforded by side-rooms and secret areas, adding variety to the players route to a pre-determined story milestone. The multiplayer nature of the other two games encourages much more exploration. As the opponent is constantly mobile, the player is encouraged to use the whole level to their advantage.

Half Life 2 doesn't offer too much help with respect to instructor feedback because the players success is merely a means to an end (story exposition), no score is offered. However, the other two games offer much more detailed information on player actions, potentially helping an instructor to see how a player acted within a play session.

Rewards are offered in two different ways. Half Life 2 focuses on in-game rewards better weapons, vehicles, and access to new areas. The other two games focus more on external rewards social standing, respect and acceptance into online clans. In both instances, the key is their benefit to the player in playing the game. The more they play, the more rewards they receive, the better their gameplay experience, the more they are motivated to continue.

The FPS genre varies in the explicitness of its goals. Half Life 2, being a character-oriented game, tends to express goals as part of NPC story exposition. In order to make its goals clear, the game employs a well-written script, and frequent NPC interaction, helping to provide regular, contextually relevant goal information, preventing players from becoming lost in a potentially confusing world.

Individual matches of TF2 revolve around an explicit goal (the game title is often the same as the goal in hand: "capture the flag", "king of the hill"). In this sense, a multiplayer game is an excellent example of a single concept implemented as a game. As such, there should rarely be any confusion as to what's going on. Battlefield 2 relies on the explicit, military-style orders. As well the level- based goal of capturing command posts, additional instructions can be given in real-time by human squad commanders,

providing their troops with well-defined short-term goals, as well as the overall long-term goals set by the game.

The games in this genre all offer a strong, immersive experience. The first person perspective literally places the player in the shoes of the character. The worlds they portray are all richly designed, helping to convince the player that they are, in fact, in the game world. There is a slight issue in the additional information that needs to be displayed (health, remaining ammunition, radar display). Typically, this is displayed around the edge of the screen, slightly shattering the illusion that the player is playing a game (this information wouldn't normally be floating in your peripheral vision).

### 6.3.2 RPG/Adventure

The three games chosen within this genre were:

- "Final Fantasy X" ("FFX", a Japanese, story-driven Role-playing game)
- "Grand Theft Auto III" ("GTA III", an action-adventure game set in a sprawling, modern city)
- "Oblivion" (a medieval fantasy RPG/adventure, focusing on exploration and non-player character interactions)

Games within this genre often revolve around an epic quest, and as such, a great deal of new information is offered throughout. All three games use non-player character ("NPC") interaction to expose information. GTA III uses key characters within the storyline, where almost every character in the other two games has something to say. This provokes players to explore the game world to find information on their own. Other methods of knowledge demonstration include a series of books to be found, detailing back-story of Oblivion, and transparent overlays used to explain aspects of GTA IIIs gameplay.

All three games rely heavily on exploration, with rich environments full of NPCs, items to be found, information to be gained and enemies to battle. However, they each limit how far a player can explore at a given point. FFX provides the player with a limited area until complete certain requisite tasks within it. GTA III restricts the areas of the city accessible to the player until they reach an appropriate stage in the story. Oblivion generally lets the player wander wherever they like, although venturing into an area with enemies much stronger than they are is likely to end in them losing the game.

RPG's rely heavily on player "stats" – values used to describe the level of their various physical and mental attributes, as well as the places they have visited, the enemies they have beaten and the items they have collected. These values could be incredibly useful

to instructors looking to assess how a player has played the game. Oblivion and FFX are both fairly traditional RPG's, with players earning experience points ("XP") for in-game success, which in turn makes their character stronger.

FFX earns overall experience points, which increase a characters stats all at once in a predetermined way. Oblivion, however, increases certain stats according to a player's actions: use a bow successfully, and your archery skill increases; convince an NPC to do something for you, and your charisma goes up. In this way, the players stats in FFX give an indication of how well the player is doing in the game at a given time, while those found in Oblivion give more detailed information on the actions a player must have carried out to reach their current status.

GTA III is more of an action/adventure game, and the player character himself never gets any better. There are still, however, a large number of stats kept, purely for the player's interest. Numbers of lampposts knocked down, longest wheelies, furthest a car has been driven backwards: all of these facts are extracted from the player's gameplay experience, and translated to a learning context, could greatly help the instructor see how a player actually played the game, as well as how they performed overall.

The balance of difficulty within RPG games is often difficult, typically relying on the process of "grinding": allowing the player to fight against weak enemies, each yielding a low number of XP, for a long time, in order to raise the level of their character. Taken to an extreme, a player could spend even longer than usual attacking these weak enemies, until their own experience level was so high, that the rest of the game would be ridiculously easy. Because of its tedious nature, "grinding" is seen as a very poor means to an end as far as enjoyable gameplay is concerned.

GTA III takes a different approach, avoiding the concept of XP altogether. Because of the games free-roaming "sandbox" nature, the player is free to try out different things whenever they please. If they find themselves stuck on a particular element of a mission, they can take time out to practice that kill in their own time, returning to the mission once they feel comfortable. This allows them to progress with the story only once they are truly ready, keeping the level of challenge much more appropriate to their own skill level.

Goal provision varies between games. GTA III and Oblivion both have "missions" or "quests", where explicit objectives are marked on a map, along with clear instructions on what they need to do when they get there. However, FFX is much more vague. The player will often know roughly where they are going, or who they are looking for, but will not know what they are supposed to do when they get there. This is usually done to maintain dramatic tension within the story, but can often leave the player confused as to exactly what they should be doing.

### 6.3.3 Puzzle

The games selected for this genre are:

- "Tetris" (the classic, block-sorting game)
- "Polarium" (a game for Nintendos handheld "DS" console, where players draw paths on the touch-screen to flip tile colours, in order to match those surrounding them)
- "Puzzle Quest" (simlar to popular online mini-game, "Bejewelled", with an additional "RPG-lite" layer on top)

Puzzle games typically do not offer any new knowledge as the game progresses, and both Tetris and Polarium qualify this. All information required to play the game is revealed in the game manual or a simple tutorial level, with no surprises occurring later on. The games complexity comes from more intricate combinations of the basic principles, rather than the addition of new gameplay mechanisms entirely.

Puzzle Quest offers an additional story, although it is very tenuously linked to the puzzle elements of the game. The interesting part of its RPG aspect is the process of "levelling up", which grants the player new skills to be used in the game. Whilst the story could be detrimental in an educational setting (by creating too great a divide between the educational segment, and the gameplay section), asking players to factor their new skills into the way they play could be an interesting way of reinforcing what they are learning.

Puzzle games are quite limited in several of the fields identified as important. The only post-game feedback they offer to an instructor is a kind of score (number of "lines" removed in Tetris and Polarium, number of XP in Puzzle Quest), making it impossible for the instructor to see how exactly the player achieved success. All three games rely on a fixed play area, with new blocks, jewels or lines added when required, making exploration impossible. Polarium has a separate "puzzle" mode, where players can create small maps and share them with friends over the consoles wireless connection. However, as the main play mode of all three games relies on a constant stream of falling blocks, traditional level design is practically impossible, and its lack of implementation makes environmental creation equally impossible.

The promotion of immersion may not seem an obvious feature of puzzle games they are typically 2D, incredibly stylised and minimal in both appearance and function. However, puzzle games are some of the most renowned for promoting "zone" play, where the player becomes lost in the game in a state of "flow" (Csikszentmihalyi 1997), working almost entirely on reflexes as they ignore external stimuli. Tetris and Polarium are more suited to foster this phenomenon. The hypnotic, constantly falling blocks, the trance-inducing

music, and the constant focus on a single area of the screen all work well to keep the player engrossed in the game ahead of any external distractions.

Puzzle Quest doesnt do this quite so well, as the story elements and skill-selection pane all distract from the main playing area. Engrossment in this game typically comes from a combination of the games "levelling up" RPG element, as well as its central gameplay mechanic.

### 6.3.4 Strategy

The three games chosen in this genre were:

- "SimCity" (a popular city development game)
- "Civilization IV" (an epic, turn-based game of expanding empires)
- "Company of Heroes" (a real-time strategy ("RTS") game, focusing on infantry and tank squads of the second World War)

Because information is essential to developing a robust strategy, all three games demonstrate new knowledge to the player in useful ways. SimCity expresses new knowledge through the state of the city itself. A player can learn that a city needs a better water supply because its houses will fall into dereliction. They will learn the importance of better inter-city roads when migration between their city and others decreases. A panel of "advisors" is also on hand to offer additional information when required.

Civilization IV is perhaps even more rigourously designed than SimCity, with a player action having a great number of ramifications in numerous other areas of the game. In addition, almost all gameplay milestones (technological advances, completion of building projects, declarations of war) are accompanied by brief, informative cut-scenes, again helping to provide a little additional information regarding important areas of the game.

Company of Heroes expands the idea of cut-scenes, offering emotively-scripted, well-directed vignettes between each mission, along with detailed briefings and debriefings about the battles involved. This helps the player to understand the strategic motivations of their in-game actions, in turn helping them to realise why the things they are doing actually work.

Exploration is handled differently within the strategy genre. SimCity offers no real opportunity for exploration, as the whole map is visible (and empty) from the offset. However, both other games use exploration quite extensively as a gameplay mechanism: Civilization on a large scale, exploring and conquering the world; Company of Heroes on a much smaller scale, infiltrating unknown enemy territory, using the terrain to your advantage as you encounter enemy troops and reclaim strategic points. In both cases,

exploration into the unknown provokes tension, exciting the player as they progress through the game.

Similarly, difficulty balance occurs in different degrees. SimCity features a kind of implicit balance, whereby players are unable to access and build certain advanced structures before they have placed a number of key, basic ones. In doing this, the player demonstrates to the game that they are comfortable enough with the way basic structures work, such that they should understand how the advanced ones work. Civilization, on the other hand, doesnt really balance difficulty in-game. Once the player chooses a predetermined difficulty level at the start of play, they are bound to it for the rest of the game, and any signs of weakness are more likely to result in A.I. opponents wiping them out, than helping them out.

Company of Heroes is even more punishing in this regard. As players defending troops die, the enemy reclaims their outposts, and the player no longer earns resources from them. This means that they cannot afford to the replace the lost troops, allowing the enemy to easily move onto the next outpost to repeat the process. This negative feedback loop can be quite frustrating, quickly forcing the player into an inescapable situation without exposing it as such.

Again, because of the importance of information availability in this genre, all games could be good at displaying a wealth of pedagogical data, were methods to edit it made available. All three games offer blocks of text, voiceovers, cinematic pieces, numerous input options, as well as the main play map itself. The strategy genre demands this information be made accessible at a moments notice – a strength that could be incredibly useful in information-heavy educational settings.

## 6.4 Analysis

Table 6.1 shows the complete results from the investigation, displaying the successes of each individual game. The first thing to notice is that the different genres do exhibit some differences in the affordances they offer.

The FPS games perform strongly in affording conversation, displaying new knowledge, encouraging exploration, immersing the player and offering rewards for success. However, they are poor at uniting resources and balancing difficulty, and are generally too fast-paced to work in blended learning scenarios.

The RPG/Adventure games lacked the FPS games support for conversation, world creation and contextualization of information, but were much better at provoking curiosity and uniting different learning resources. This genre of game, therefore, may be better suited to a multimedia-heavy learning area, where learners need to explore a range of different learning resources in a self-motivated manner. In contrast, the FPS genre may

TABLE 6.1: The affordances offered by the different games investigated

| | **First-Person Shooter** | | | **RPG/ Adventure** | | | **Puzzle** | | | **Strategy** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| **Conversation** | X | X | X | | | | | | | | | |
| **New Knowledge** | X | X | X | X | X | X | | | X | X | X | X |
| **World Creation** | X | X | | | | | | X | | | | |
| **World Exploration** | X | X | X | X | X | X | | | | | X | X |
| **Useful Feedback** | | X | X | X | | X | | | | X | X | X |
| **Balance Difficulty** | | | | | | X | | | | X | | |
| **Clear Goals** | | X | X | | X | X | X | X | | | | X |
| **Contextualisation** | X | X | X | | | X | X | X | X | | | X |
| **Provoke Curiosity** | X | | | X | X | X | | | | | | |
| **Immersion** | X | X | X | X | X | X | X | X | X | | | |
| **Offer Rewards** | X | X | X | X | X | X | | | X | X | X | X |
| **Unite Resources** | | | | X | X | X | | | | X | X | X |
| **Blended Support** | | | | | | | | | X | X | X | |
| **Full Pedagogy** | | | | | | | | | | | | |
| **Standards** | X | X | | | | | | X | | | | |

be better at providing a setting where the environment itself is the learning resource to explore, with its opportunities for conversation allowing multiple users to be present in it at once.

The puzzle genre lacks many of the affordances offered by the previous two game types, but excels in its clear provision of goals, its opportunity to contextualise information well, and its deep immersive properties. This type of game may be better suited to explaining a single, important concept. It would allow the user to immerse him- or herself in a working example of the concept, in order to thoroughly explore its intricacies without external distractions.

The strategy genre excels at providing new knowledge, uniting different resources and expressing information extremely clearly. It also often works well in blended learning situations, making it a strong candidate to enhance current, information-heavy teaching styles. The game could easily be played alongside a traditional, instructor-led session, with its efficiency at displaying rich, dense information being a strong replacement for the textbook. The detailed feedback offered to the user regarding their performance would also assist the instructor in assessing how well the learner had done.

### 6.4.1 Learning Styles

Understanding these genres more clearly could also help to determine which type of game is most suitable for a given learning style. Here, the tables from Chapter 2 are augmented to show this correlation. The lower section of the table shows how suitable each genre is, "1" being the most suitable, "4" being the least, with a dash representing an unsuitable genre. These figures were generated based on the requirements of each learning style studied in Chapter 2 (see Table 2.2), compared to those offered by the genres in this chapter (see Table 6.1).

TABLE 6.2: A list of different learning styles mapped to the requirements harvested from previous work, along with the suitability of different genres in supporting them ("1" being most suitable, "4" least suitable and a dash indicating an unsuitable genre)

| **Criterion** | **Constructivist** | **Behaviourist** | **Scaffolding** | **Vicarious Learning** | | | |
|---|---|---|---|---|---|---|---|
| | | | | **Modelling** | **Eliciting** | **Disinhibitory** | **Inhibitory** |
| Conversation | X | | | X | | | |
| New knowledge | X | | X | X | | | |
| World creation | | | | | | | |
| World exploration | X | | | | | | |
| Useful feedback | X | X | X | | | X | X |
| Balance difficulty | | X | X | | | | |
| Clear goals | | | | | X | | |
| Contextualisation | X | | X | | X | | |
| Provoke Curiosity | | | | | | | |
| Immersion | | | | | | | |
| Offer rewards | | X | | | | X | |
| Unite resources | | | | | | | |
| Blended support | | | | | | | |
| Full pedagogy | | | | | | | |
| Standards | | | | | | | |
| **FPS** | 1 | 2 | 1 | 1 | 1 | 2 | 2 |
| **RPG/Adventure** | 2 | 1 | 2 | 2 | - | 2 | 2 |
| **Puzzle** | 4 | 3 | - | - | 1 | - | - |
| **Strategy** | 3 | 1 | 2 | 2 | - | 1 | 1 |

TABLE 6.3: A list of different learning styles mapped to the requirements harvested from previous work, along with the suitability of different genres in supporting them ("1" being most suitable, "4" least suitable and a dash indicating an unsuitable genre)

| **Criterion** | **Motivation** | | | | **Bloom's Taxonomy of Learners** | | |
|---|---|---|---|---|---|---|---|
| | **Expressive** | **Achievement** | **Social** | **Instrumental** | **Remembering** | **Understanding** | **Applying** |
| Conversation | | | X | | | | |
| New knowledge | | | | | X | X | X |
| World creation | | | | | | | |
| World exploration | X | | | | | | |
| Useful feedback | X | X | X | | | | |
| Balance difficulty | | | | | | | |
| Clear goals | | X | X | | | | X |
| Contextualisation | | | | | | X | X |
| Provoke Curiosity | | | | | X | X | X |
| Immersion | | | | | | | |
| Offer rewards | | | | X | | | |
| Unite resources | | | | | | | |
| Blended support | | | | | | | |
| Full pedagogy | | | | | | | |
| Standards | | | | | | | |
| **FPS** | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **RPG/Adventure** | 1 | 1 | 2 | 1 | 1 | 2 | 2 |
| **Puzzle** | - | 2 | 3 | 1 | - | 3 | 2 |
| **Strategy** | 1 | 1 | 2 | 1 | 1 | 3 | 3 |

TABLE 6.4: A list of different learning styles mapped to the requirements harvested from previous work, along with the suitability of different genres in supporting them ("1" being most suitable, "4" least suitable and a dash indicating an unsuitable genre)

| **Criterion** | **Bloom's Taxonomy of Learners** | | | **Honey & Mumford** | | | |
|---|---|---|---|---|---|---|---|
| | **Analysing** | **Evaluating** | **Creating** | **Activist** | **Reflector** | **Theorist** | **Pragmatist** |
| Conversation | | | | | | | |
| New knowledge | X | X | X | | X | X | X |
| World creation | | | X | X | | | X |
| World exploration | | | | X | | X | X |
| Useful feedback | | X | X | | X | X | X |
| Balance difficulty | | | | | | | |
| Clear goals | X | X | X | | X | | |
| Contextualisation | X | X | X | | | X | X |
| Provoke Curiosity | | | | X | | | |
| Immersion | | | | | | | |
| Offer rewards | | | | | | | |
| Unite resources | | | | | | | |
| Blended support | | | | | | | |
| Full pedagogy | | | | | | | |
| Standards | | | | | | | |
| **FPS** | 2 | 2 | 1 | 2 | 1 | 1 | 1 |
| **RPG/Adventure** | 1 | 1 | 2 | 1 | 1 | 2 | 1 |
| **Puzzle** | 3 | 3 | - | - | - | - | 3 |
| **Strategy** | 3 | 2 | 2 | - | 1 | 3 | 2 |

FPS games' combination of new knowledge, exploration and opportunities for contextualisation makes them potentially useful in supporting constructivist learners, Bloom's "creators", and Honey and Mumford's "theorists" and "pragmatists". The in-game conversation offered by many of these games could be useful to both constructivist learning and social motivation, which in turn could be helped by the genre's timely feedback and clear provision of goals.

The RPG/Adventure genre supports Bloom's "analysts" and "evaluators" by providing new knowledge and contextualisation opportunities, while provoking curiosity in the player. Honey and Mumford's "activists" and "pragmatists" are also supported by the genre's explorable environments, along with the curiosity generated within them.

Puzzle games don't appear to serve any of the learning styles particularly well, except for vicarious "eliciting". Here, the basic framework of clear goals combined with an environment in which the player can continually contextualise what they learn provides a focused environment in which to re-model the "master's" actions in a gradually developing way.

Strategy games' provision of detailed feedback and rewards makes them excellent in supporting behaviourist learning, as well as disinhibitory vicarious learning. In both of these cases, the rewards show the player that they have done something correctly, while the feedback helps to tell them what that thing was, as well as how they achieved it.

Several types of learning could be served equally well by a number of genres. The different rewards offered by any of the games make them suitable to foster instrumental motivation The new knowledge offered by all but the puzzle genre, combined with their provocation of curiosity make them useful in supporting Bloom's "remembering" learners. In addition, these three genres' combination of new knowledge, useful feedback and clear goals (each with different intensities) makes them equally useful to Honey and Mumford's "reflectors".

## 6.5 Conclusions

The results of the investigation suggest that different gaming genres do indeed offer different affordances that might be useful in educational contexts. These results contribute to the idea that when considering the usefulness of "computer games" as educational tools, it is important to understand these differences. As we have seen, where one type of game fails, another may excel.

The genres chosen for this study are by no means exhaustive. There are others besides (simulators, sports games, the whole range of "casual" games), as well as within those chosen here. For example, the Massively Multiplayer Online genre of RPGs deserve an entire section on its own, far beyond the scope of this initial investigation. In addition,

the games selected for the study are only a few out of hundreds in each genre, selected as being representative, rather than exhaustive.

As such, plenty of room remains for further investigation in this area, broadening and deepening the community's understanding of the intricate differences between game types, and the similarities between them. This further study will provide a more in-depth look into how the affordances offered by multiple gaming genres differ, taking into account their particular strengths and weaknesses in more detail, while continuing to explore how this might affect their usefulness in an educational context.

# Chapter 7

# Looking Deeper

## 7.1 Introduction

The results of the initial genre investigation begin to show some differences between gaming genres, as well as similarities between games within each genre. However, the investigation was only intended to be an initial exploratory study, with a small sample size and user base. In order to achieve more robust statistical validity, the number of genres studied, the number of games chosen from each genre, and the number of users will all need to be increased. In addition, the criteria used in evaluating the games will need to be modified, based on the results of the initial study.

The aim of this deeper investigation is to produce a framework to classify computer games by genre, indicating the different gameplay features likely to be present within each genre. This framework will potentially be useful to several different user groups: educators will be able to use the framework to select an appropriate genre of game, based on their learning outcomes and the different skills they want their students to develop; games developers will be able to use it as a "checklist" of qualities, to ensure their game offers as many features as it could do, within its designated genre; it may also be useful to researchers, indicating which areas of learning a particular game or genre may affect.

### 7.1.1 Hypothesis

I predict that a set of computer games taken from different genres will possess sufficiently different gameplay elements *between* genres, and sufficiently similar gameplay features *within* genres, that reliable classification of the genres based on these feature-sets will be possible.

$H_0$: The gameplay feature-sets of computer games taken from different genres will not be significantly different, making reliable or useful classification of the games based on their genre impossible.

$H_1$: The gameplay feature-sets of computer games taken from different genres will be i) significantly different between genres and ii) significantly similar within each genre, such that reliable and useful classification of the games can be made based on their respective genres.

In addition, I predict that across all genres, there will be a positive correlation between the overall quality of the games studied and the number of educational requirements these games meet, i.e. the more features a game offers, the more fun it will be to play.

$H_0$: There will be no correlation between the quality of a game and the number of educational requirements it satisfies.

$H_1$: There will be a positive correlation between the quality of a game and the number of educational requirements it satisfies.

The reliability and usefulness of the results will be determined by the statistical significance of the results, using $p$-value hypothesis testing. Reliability will exist if the features identified within each genre's feature-set are significantly different from a random set of responses. Usefulness will occur if the feature-sets identified are significantly different for each other.

Having made a hypothesis, an experiment is now needed in order to test it. To prove or refute the hypothesis, data representing how well a number of different games satisfy a set of criteria will be required. Therefore, three things are required: a final set of criteria, representing the potential qualities of a well-made game; a survey to harvest data on how well a number of games satisfy these requirements; and a number of analytical methods to understand what this data means, with respect to the hypothesis. This chapter will explore each of these three areas, finalising each of them before the experimental process begins.

## 7.2 Analytical Methods

This experiment will be used to assess different games based on the degree of success with which they offer certain gameplay features. The games' differing success in these gameplay areas will be used to group them into categories. In order to make this assessment possible, the experiment will generate quantitative data in the form of feature "scores" for each game that is assessed. Once this data is generated, the games can be grouped based on their scores in different combinations of features.

Certain analytical methods will be needed to make sense of this multidimensional data, to reduce the number of dimensions to a scale that can be more easily interpreted. To evaluate the correlation between the number of affordances offered and the quality of a game, simple significance testing will suffice. The average scores for each educational affordance will be measured against the possible scores recorded for "fun". In doing so, the significance of any correlations will be measured. A significant ($p < 0.5$) result would suggest a correlation between feature support and game quality, while an insignificant result ($p > 0.5$) would suggest no correlation.

To evaluate the clustering of the different games, Multiple Discriminant Analysis (MDA) will be used. MDA is used, amongst other things, to assess the importance of different independent variables in classifying a dependent variable. In this case, the importance of supporting the different educational requirements will be evaluated when determining which genre a game belongs to. In addition, MDA can also be used to determine whether cases are classified as predicted – in this case, whether the games selected from a given genre actually belong to that genre when considered in terms of the educational affordances offered. As such, our results should be able to tell us two things: whether the genres selected are actually valid, and which educational affordances each of those genres is statistically most likely to offer.

## 7.3 Generating the Results

User surveys will be most appropriate in harnessing the kind of data that is required for this experiment. Questionnaires can be constructed similar to those used in market research, in order to gauge users' opinions on different aspects of a product. In this case, the products are computer games, and the aspects of the product will be represented by the established set of criteria. By using a Likert-like scale, the the users will be able to show how strongly they feel that each of the criteria are met by a certain game, in a way that can be quantitatively analysed.

In order to limit the effect of additional, external factors on the results, "expert" users will be chosen from groups of computer gaming enthusiasts. By choosing users already familiar with how games work, their answers should be less affected by problems such as installing and running the games, manipulating a complex videogame controller, or understanding potentially confusing mechanisms used by game designers that game enthusiasts now take for granted. In addition, it can be assumed that these users have already played a wide range of games. This will allow them to answer the questionnaires from their own experience, without the usual "familiarisation" session required for typical software evaluations.

The survey will be run in two stages, to incorporate potential changes based on the results obtained. The first stage will be a small pilot survey, with around ten participants

taken from the research lab. Participants may not be "expert" users at this stage, so will be allowed to choose which game they will assess to avoid being prescribed a game they have not played. This stage will primarily be used to test the deployment of the questionnaire (can it be accessed online, do the questions make sense, are the responses labelled correctly). With such a small data set, it will be difficult to draw any significant conclusions from the results, but any obvious mistakes can be corrected before the next stage.

The second phase will involve around one hundred users, taken from within the university. Recruitment for the survey will be targeted at users with some existing game experience. Due to the increased likelihood of these participants having played most of the popular games currently available, specific games can be chosen for this phase of the experiment. This will increase the number of responses for each given game, increasing the reliability of the results. The option to choose "other" will still be available in each genre, although participants will be encouraged to review the prescribed games where their experience permits.

The ultimate result of the experiment will be a set of data representing a number of different games, along with how well the gaming community considers them to satisfy the previously generated criteria. This data will be used to analyse how likely different types of game are to satisfy each of the criteria, as well as to see which criteria are most important in creating an enjoyable game experience.

## 7.4 Assessment Criteria

So far, the criteria for assessing the games have remained unchanged since their conception. However, the results of the mini-game and genre investigations suggest that some changes should be made.

### 7.4.1 Criteria to be Removed

The criterion, "Allow the full pedagogical meaning of data to be expressed", has so far been used in two different ways. During the mini-games study, it was understood to mean, "Is *capable* of expressing the required pedagogical meaning", i.e. had sufficient expressive mechanisms (text blocks, audio tracks, animations etc.) to communicate any pedagogical meaning that might be present.

The genre study, however, understood the criterion to mean "Actually *contains* a quantity of pedagogical data, and expresses it completely". In their respective studies – and corresponding interpretations of the criteria – 14 of the 26 mini-games met this criterion, while none of the games in the genre study did so.

This variation in interpretation could cause confusion in a user study, with different interpretations yielding quite different results. As the focus of the research has shifted from specifically educational games, towards the differing qualities of games in general, the omission of this criterion should remove any confusion, without affecting the use of the data in proving the hypothesis.

Another of the criteria, "Support blended learning", needs to be addressed. Currently, the concept of blended learning is considered a gameplay "feature", like any of the other criteria. However, blended learning is still a type of learning. As the set of criteria is intended as a set of requirements for enabling good learning through games, blended learning should perhaps not be a criteria itself, but rather another "column" in the table, represented by each of the other criteria.

For example, many of the games fail to offer mechanisms for communication between players. However, a blended learning scenario would provide these mechanisms through class discussions, effectively providing communication functionality to the players. Conversely, many of the games offered immersive environments, in which players could lose themselves, maintaining a "flow" state. This state of immersion, however, may not be so effective if players are forced to stop every ten minutes to engage in class discussion. Because of the complex nature of blended learning's impact on gameplay, it falls outside the scope of this investigation and will be omitted from the list of criteria.

During the pilot study, the concept of difficulty balance was split into two distinct questions, asking the participant whether the game was frustratingly hard or easy to the point of boredom. As both of these questions returned identical results for any given game, they will be merged into a single question related to difficulty balance for the final experiment.

Finally, the criteria, "Allow instructors to establish experiential, explorable environments that are contextually relevant" and "Offer compatibility with different standards" have been merged into one criterion. In the context of game design and development, both are understood in relation to re-usable, user-generated content. As the genre study yielded the same responses for both criteria, no extra information is likely to be gained by keeping the criteria separate.

### 7.4.2 Criteria to be Added

The remaining criteria are all taken from the research into learning environments at the beginning of this thesis. As the investigation has become more focussed on game design, it seems reasonable to include some criteria from game design theory. "The 400 List" is a collaborative list of criteria for good game design and development, maintained by luminary computer game designers. Currently still in progress, the list aims to represent the 400 most important considerations when designing a game. The current requirements

were examined and categorised, in an attempt to both validate the current experimental criteria as well as generate some new ones.

Of the remaining criteria from the original list, eight of them were represented in some way in "The 400 List". These criteria, along with a selection of the list entries that applied to them can be seen in Table 7.4.2. The remaining list entries were categorised into a further eight groups. The largest group covered the game development process, and was therefore outside the scope of this evaluation. A further groups of requirements was described as "Meeting the Users' Needs" – in this case, catering to the sensibilities of certain nationalities, genders, or fans of certain genres. However, as the list of criteria in this investigation aims to represent the needs of teachers and learners, including this condition as an individual criterion would be unnecessary.

| **Existing Criteria** | **Corroborating "400 List" Criteria** | |
|---|---|---|
| | **No.** | **Examples** |
| Provide feedback on learners' (players') actions | 8 | –"Provide a reaction to every player action"<br>– "Give player [...] clear indication of how to become better" |
| Maintain a balance between boredom and frustration | 5 | – "Vary rate of difficulty increase within the flow channel"<br>– "Use negative feedback to balance game difficulty and player skill" |
| Provide explicit goals | 3 | – "Provide clear short-term goals"<br>– "Players should see their goal before they achieve it" |
| Motivate through the provocation of curiosity | 2 | –"Provide visual "weenies" to draw player [attention]"<br>– "Make sub-games" |
| Promote a sense of immersion within the game environments | 2 | – "Maintain suspension of disbelief"<br>– "Show character through action" |
| Offer rewards when goals are achieved successfully | 2 | – "Make rewards proportional to the difficulty of the task required to earn them"<br>– "Provide outward and visible signs of accomplishment" |
| Create opportunities to explore the game world | 1 | – "Emphasise exploration and discovery" |
| Allow the learner (player) to integrate new information with their existing knowledge | 2 | – "Set up expectations about how the game works, then reinforce them"<br>– "Things that look alike should behave alike" |

TABLE 7.1: A list of the original criteria that were corroborated by criteria from "The 400 List"

Another group represented certain "logistic" ideas surrounding the actual playing of games. This group included ideas like "being able to save the current game-state at any point" and "be able to explain the rules to a casual game in three sentences". While

valid, these ideas relate to activities surrounding the act of game play, rather than to the act itself. These ideas could certainly be explored in future work, but at present lie outside the scope of the investigation. A further group contained four "rogue" entries which were either poorly explained, or directly contradicted more suitable rules, and as such will also be omitted from the investigation.

| **Emergent Category** | **Corroborating "400 List" Criteria** | | |
|---|---|---|---|
| | **No.** | **Criteria** | **Examples** |
| Development process | 26 | 8, 9, 15, 17, 18, 21, 29, 30, 32, 33, 37, 38, 41, 42, 43, 44, 45, 63, 76, 80, 90, 92, 93, 94, 101, 104 | – "Detailed design docs for novice teams"<br>– "Begin each project with a one-page specification of the gameplay"<br>– "Design to fit the revenue stream"<br>– "Write player narrative [use case] to identify problems" |
| Provide variety/ choices | 13 | 13, 16, 22, 52, 57, 58, 60, 64, 68, 97, 102, 105, 109 | – "Make challenges vary in more than degree"<br>– "Provide multiple solutions to challenges" |
| Facilitate narrative expression | 11 | 14, 23, 40, 46, 65, 82, 83, 88, 89, 111, 112 | – "Use camera position to elicit emotional involvement"<br>– "Design levels with backstory" |
| Be intuitive/ immersive | 9 | 27, 50, 51, 78, 79, 84, 96, 103, 107 | – "Keep the interface consistent"<br>– "Make consequences of actions predictable" |
| Promote fun | 8 | 19, 24, 36, 47, 59, 77, 87, 106 | – "Make the game fun for the player, not for the designer"<br>– "Have fun in the first minute" |
| Meet users' needs | 7 | 34, 35, 48, 49, 56, 66, 91 | – "Emphasise micro-management for German speakers"<br>– "Provide indirect competition [to match typical female play-styles]" |
| Gameplay "logistics" | 4 | 7, 72, 95, 110 | – "Let the player turn the game off"<br>– "Emotional value must exceed load time" |
| Miscellaneous/ ill-explained | 4 | 31, 81, 86, 99 | – "Imply more depth than is there"<br>– "Differentiate between game design and experience design" |

TABLE 7.2: A list of the emergent categories from the requirements in "The 400 List"

The remaining four categories could each help to generate useful results. The largest of these categories was labelled as "Offer choices and variety", and contained suggestions such as "Turn Constants into Variables", "Add a Small Amount of Randomness to AI Calculations" and "Make Challenges Vary in More than Degree". Variety could be useful to education in several different ways. By offering choices, self-directed learners can decide which tasks to attempt for themselves, instead of being prescribed tasks which

may push them outside of their "flow zone". The onset of boredom can be postponed by introducing new and interesting elements to an otherwise linear game, again helping to keep players in a state of "flow".

Another interesting benefit relates to Steinkuehler's work on scientific method in the MMORPG genre (Steinkuehler & Chmiel 2006). On of the problems with using games to teach, particularly in science, is that they fail to convey the pragmatic nature of certain rules. Typically, if something works in a game the first time, it will work every time (as long as the original conditions are maintained). One of the key tenets of scientific method is that it is *pragmatic*: while past observations give the best idea possible of what will happen in a given situation, there is no *guarantee* that it will happen as expected. By adding even a small amount of variety to the A.I. which drives the game, it can be made to behave in the expected way for the majority of the time, but with a small chance of behaving erratically. This would allow players to develop an understanding of the core concept, without ignoring the possibility that the rules might not always apply in exactly the same way.

Nine more of the suggested criteria were grouped together under the heading, "Be Intuitive and Immersive", whereby a player should never be directly asked, or unexpectedly forced to leave the game environment mid-game. These criteria included, "Make the First Player Action Painfully Obvious", "Keep the Interface Consistent" and "Design Levels to Conceal Camera Flaws". Forcing a player to read a manual in the middle of a dramatic, engaging scene, or having the camera disappear inside a mountainside while looking over an otherwise beautiful panoramic sunset will immediately destroy any sense of immersion the player may be feeling. By ensuring that the players interactions with the game are as consistent and intuitive as possible, the sense of immersion – and as a result, the "flow" state – will be prolonged.

The remaining two categories relate to more long-term "outputs" of games: their ability to successfully convey a story or emotion, and their capacity to invoke "fun" in the player. These features could be seen to represent the two (often conflicting) sides of an educational game: some concept must be successfully conveyed for the game to be educational, but unless it is "fun", is it really a game at all? As such, the measure of how successfully these criteria are realised would be a good measure of how successful a particular educational game actually was. This investigation focusses on the qualities required for a good game, and therefore will include the criterion of being "fun". The criterion of being able to "convey a concept or emotion", however, is still valid, and will be saved for future work into the educational use of games.

## 7.5 Analysis of Results

### 7.5.1 Game Quality

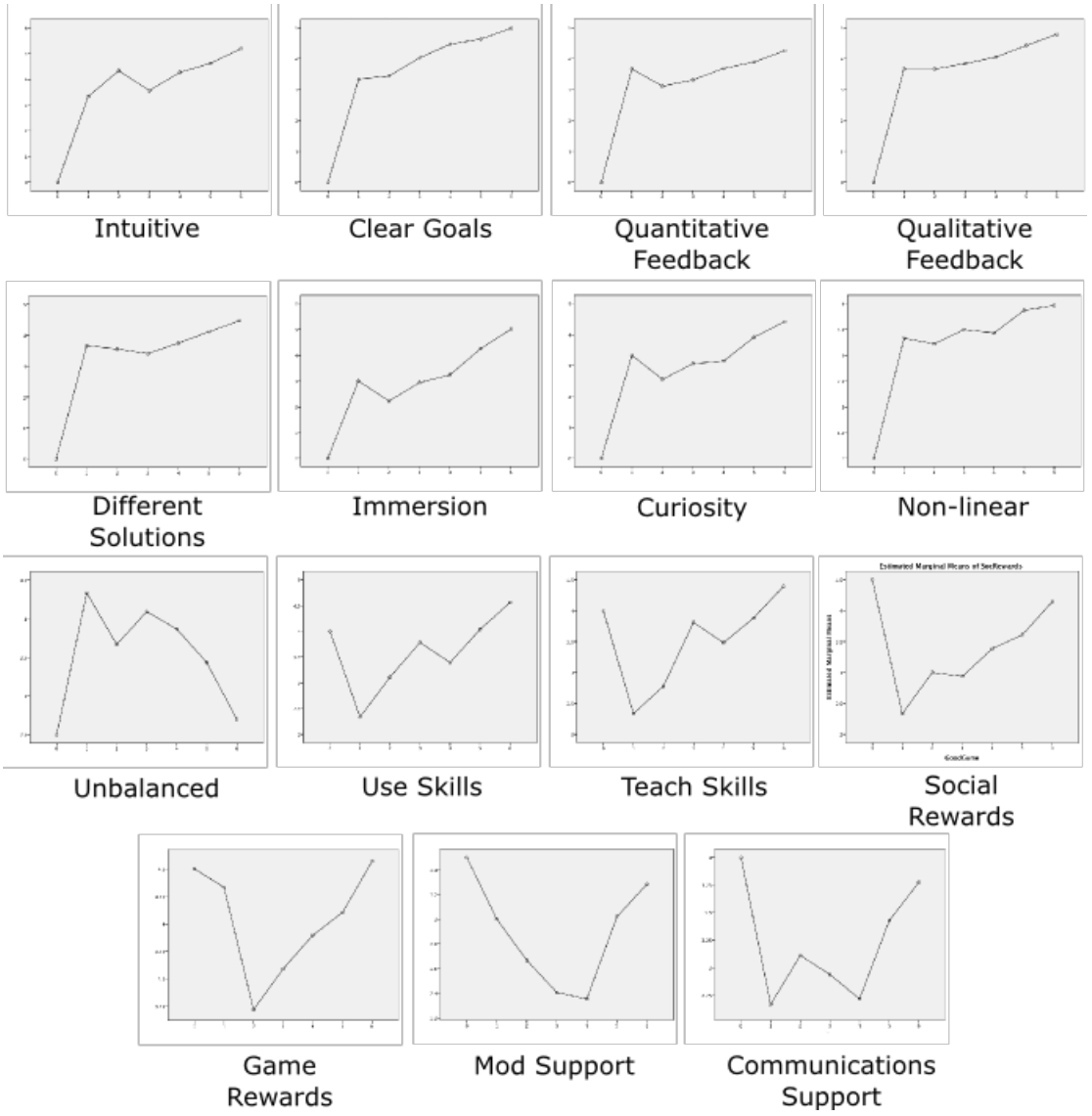


FIGURE 7.1: Graphs of each feature plotted against "goodgame" (an indication of how fun the player thought the game was)

In total, 961 individual game reviews were submitted by the participants. Figure 7.1 shows that there is a general positive correlation between the values given for "goodgame" and the values of the individual features, i.e. a positive correlation between the quality of each feature and the overall quality of the game. This result allows us to refute the $H_0$ for this part of the experiment (i.e. that there exists no correlation between requirements met and overall game quality), and reinforces the idea that the features determined throughout this thesis are conducive to a fun gameplay experience. A slight anomaly is found in the correlation between "Mods" and overall game quality. The plot suggests that game quality is highest with either excellent support for user-created

modifications, or with no such support at all. The middle ground, where "acceptable" levels of support are offered, correlates with a low score for game quality.

### 7.5.2 Separation of Genres

| Gameplay Features | Genre | | | | |
|---|---|---|---|---|---|
| | Action | Online | Puzzle | RPG | Strategy |
| Support communication between players | -0.856 | 0.457 | -1.585 | -2.526 | -0.508 |
| Allow players to modify the game, using editing tools or programming APIs | -1.715 | -1.096 | -1.137 | -2.294 | -0.965 |
| Reward the player with in-game resources | -0.375 | -0.186 | -0.353 | 0.309 | -0.455 |
| Reward the player in a socially-visible way | -0.579 | 0.059 | -0.629 | -1.562 | -0.662 |
| Teach new skills throughout the game | -0.696 | -0.936 | 0.047 | -0.098 | -0.449 |
| Require that the player use their skills throughout the game | -0.443 | -0.761 | 0.306 | -0.196 | -0423 |
| Use difficulty balance to maintain the player's state of Flow* | -1.778 | -1.814 | -0.158 | -1.634 | -1.178 |
| Allow the player to complete the game in a non-linear fashion | -1.730 | -0.340 | -0.423 | -0.407 | -0.269 |
| Provoke curiosity in the player | -0.472 | -0.979 | -0.439 | 0.175 | -0.699 |
| Foster an immersive environment | 0.173 | -0.271 | 0.025 | 0.031 | -0.354 |
| Accept different possible solutions for a given problem | -0.919 | -0.378 | 0.474 | -0.552 | 0.019 |
| Provide qualitative feedback on the player's actions | -0.157 | -0.096 | 0.847 | -0.304 | -0.109 |
| Provide quantitative feedback on the player's actions | -0.880 | -0.580 | 0.479 | -0.753 | -0.609 |
| Set out clear goals for the player to achieve | 0.081 | -0.011 | 1.744 | -0.629 | 0.146 |
| Provide intuitive interaction mechanisms | 0.280 | -0.027 | 1.652 | -0.412 | 0.098 |

TABLE 7.3: The taxonomy of gameplay features present in each different genre, based on the results of the experiment

A discriminant analysis was performed on the results of these reviews, in order to determine whether the chosen criteria were appropriate when trying to separate genres. By performing the analysis with the full set of criteria, a Wilks' Lambda of 0.262 was generated, suggesting that the criteria separate the genres well. However, this value is quite strongly accounted for by the "allow communication between players" ("Comms") and "offer social rewards" ("SocRewards") criteria. While these two criteria offer good

separation, they only really separate the "Online" genre from the remaining four. This separation is clear and significant, but perhaps not so useful when trying to separate all five genres from each other.

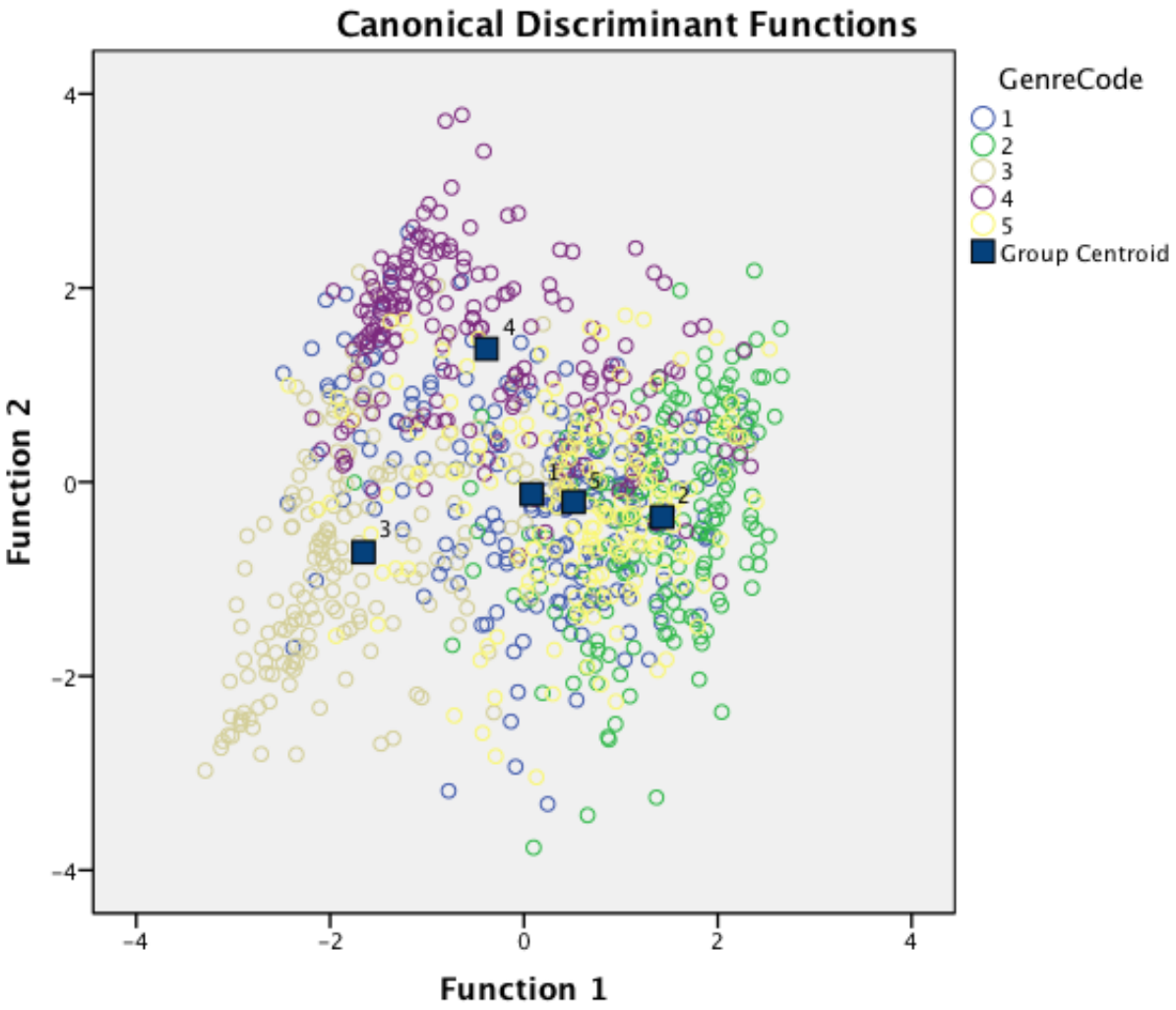


FIGURE 7.2: Graph of group centroids of genres, plotted against the primary and secondary discriminant functions. GenreCodes represent 1) Action, 2) Online, 3) Puzzle, 4) RPG and 5) Strategy.

If we remove the first discriminant function from our analysis, we are still left with a significant separation result, this time with a Wilks' Lambda of 0.527. While less separation is achieved without this function (only 43% of variance is explained by the remaining three functions), the result is still significant. We can examine the criteria which make up the remaining discriminant functions, to try and determine the "type" of games that they might represent.

In the case of the second discriminant function, "Immersion", "GameRewards" and "Curiosity" all contribute strongly when deriving the function, and "TeachSkills" and "UseSkills" also feature in the resulting discriminant. This suggests that games which

score highly along this dimension would suit a player who likes to explore, offering an immersive world with plenty of areas for them to investigate. It may also suit a behaviourist style of learning, where new skills are taught, then rewards are given for exercising them correctly. The pairing of "Curiosity" and "GameRewards", combined with "Immersion" could provide a strong sense of "Flow" within this type of game. An immersive game should help the player ignore external distractions, while the elements to provoke – and reward – their curiosity should motivate them to progress through the game.

The third function is identified by "NonLinear" and "DiffSolutions". Games within this category would likely suit a player who likes to try out different strategies, perhaps experimenting with various "right" and "wrong" solutions across multiple play-throughs, in order to understand what the game is asking them to do. The fourth function contains high scores for "Unbalanced" and low scores for "QuantFeedback" and "QualFeedback". While this function only accounts for 1.3% of variance between genres, it does highlight an interesting connection between the level of feedback offered by a game, and whether the player considers the game to be unfairly balanced, i.e. that a game which offers very little feedback on the user's input is likely to be unfairly difficult.

| Function | | Eigenvalue | % Variance | Cumulative % | Canonical Correlation |
|---|---|---|---|---|---|
| Dimension: | 1 | 1.013 | 57.0 | 57.0 | 0.709 |
| | 2 | 0.521 | 29.3 | 86.4 | 0.585 |
| | 3 | 0.219 | 12.3 | 98.7 | 0.424 |
| | 4 | 0.023 | 1.3 | 100.0 | 0.151 |

TABLE 7.4: Eigenvalues for the discriminant analysis of all surveyed games.

If we remove the first discriminant function's criteria from the analysis completely, the discriminant functions change slightly. While the features within each function remain the same, the functions themselves now account for greater percentages of variance. Function one (containing "curiosity", "immersion", "gamerewards", "teachskills" and "useskills") now accounts for 63% of the variance, again separating the "RPG" genre more clearly than any other. This seems appropriate for a genre focussing on exploration of rich worlds, skill progression and reward acquisition. Function two (containing only "nonlinear" and "diffsolutions") accounts for a further 23% of variance, separating the "action" genre from the "online" and "strategy" genres most clearly. This again seems appropriate: the "action" genre typically features a linear progression through a set of predetermined "levels", and scores poorly; the "strategy" genre allows for diverse branching decisions, and scores highly.

| | Function | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| **Comms** | *0.916* | -0.325 | -0.113 | 0.046 |
| SocRewards | *0.448* | 0.051 | -0.033 | -0.099 |
| **Curiosity** | 0.174 | *0.633* | -0.166 | 0.310 |
| **GameRewards** | 0.335 | *0.597* | -0.057 | -0.323 |
| **Immersion** | 0.269 | *0.409* | -0.365 | 0.110 |
| TeachSkills | 0.146 | *0.388* | 0.008 | 0.038 |
| UseSkills | 0.138 | *0.376* | 0.035 | 0.128 |
| Intuitive | -0.014 | *-0.214* | -0.103 | -0.138 |
| ClearGoals | 0.057 | *-0.180* | -0.011 | -0.176 |
| **NonLinear** | 0.319 | 0.344 | *0.684* | -0.205 |
| **DiffSolutions** | 0.188 | 0.110 | *0.469* | 0.272 |
| **Mods** | 0.344 | -0.084 | 0.169 | *0.454* |
| **QuantFeedback** | 0.108 | 0.084 | 0.202 | *-0.418* |
| **Unbalanced** | -0.003 | 0.049 | 0.295 | *0.405* |
| QualFeedback | 0.054 | 0.109 | 0.087 | *-0.189* |

TABLE 7.5: Structure matrix for the discriminant analysis of all surveyed games. Note, values in italics represent the largest absolute correlation between a variable and a function, while variables in bold represent the variables used to perform the analysis.

| Test of Function(s) | | Wilks' Lambda | Chi-Square | df | Sig. |
|---|---|---|---|---|---|
| Dimension: | 1 through 4 | 0.262 | 1276.425 | 40 | 0.000 |
| | 2 through 4 | 0.527 | 610.015 | 27 | 0.000 |
| | 3 through 4 | 0.802 | 210.511 | 16 | 0.000 |
| | 4 | 0.977 | 21.937 | 7 | 0.003 |

TABLE 7.6: Wilks' Lambda for the discriminant analysis of all surveyed games.

### 7.5.3 Genre Breakdown

Further analysis on a per-genre basis exposes further interesting information about the individual games themselves. Interestingly, no clear separation was found between the games within the "Strategy" genre. This suggests that the games selected for the survey offer significantly similar gameplay experiences with respect to our chosen gameplay features.

#### 7.5.3.1 Action

In the "Action" genre, the functions responsible for the greatest variance are made up of i) a poor score in "quantfeedback" and ii) high scores in both "gamerewards" and "useskills".

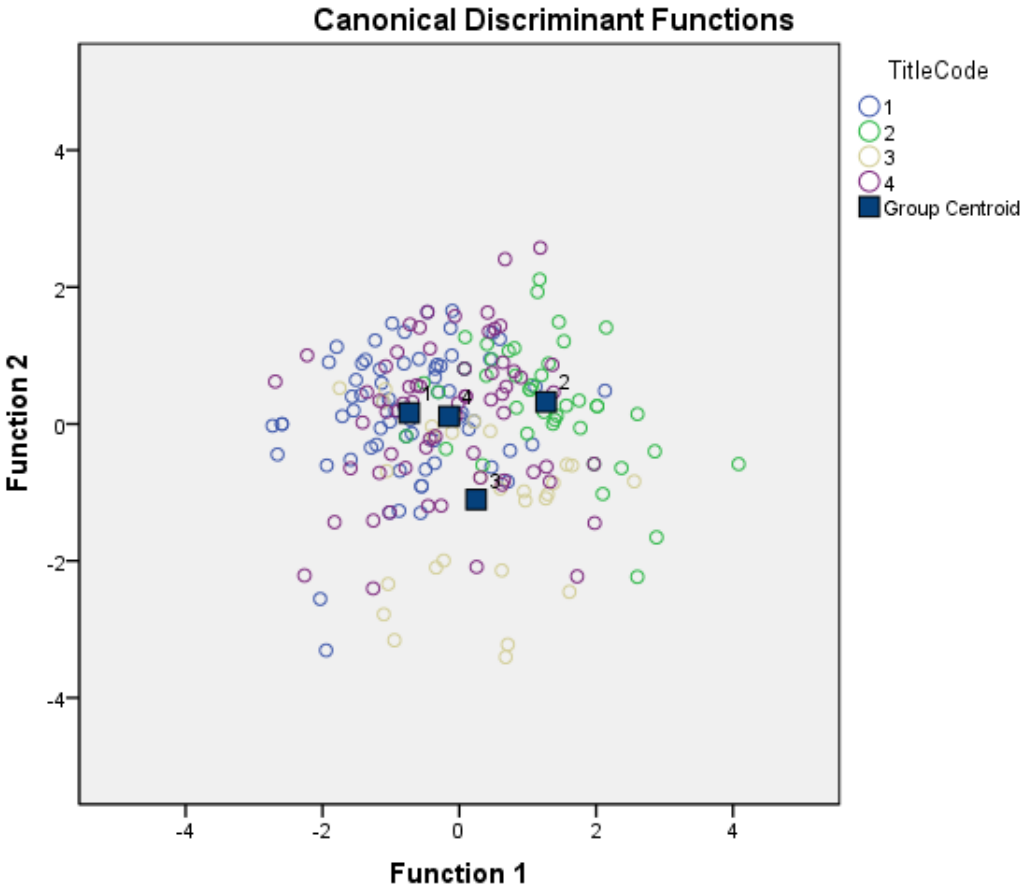


FIGURE 7.3: Action games, plotted against dimension one (poor quantitative feedback) and dimension two (consistent use of player's skills and good provision of the rewards). TitleCodes represent 1) "Call of Duty 4", 2) "Half Life 2", 3) "Halo 3" and 4) the assorted remaining Action games.

| Function | | Eigenvalue | % Variance | Cumulative % | Canonical Correlation |
|---|---|---|---|---|---|
| Dimension: | 1 | 0.533 | 68.1 | 68.1 | 0.590 |
| | 2 | 0.210 | 26.8 | 95.0 | 0.416 |
| | 3 | 0.039 | 5.0 | 100.0 | 0.195 |

TABLE 7.7: Eigenvalues for the discriminant analysis of games within the "Action" genre.

| | Function | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| **QuantFeedback** | *-0.269* | -0.220 | -0.026 |
| NonLinear | *0.168* | -0.086 | 0.013 |
| DiffSolutions | *0.154* | -0.117 | 0.048 |
| Unbalanced | *0.028* | 0.022 | 0.027 |
| **GameRewards** | -0.417 | *0.691* | 0.196 |
| **UseSkills** | 0.446 | *0.638* | -0.099 |
| TeachSkills | 0.146 | *0.482* | -0.087 |
| **Mods** | 0.432 | -0.241 | *0.811* |
| **Curiosity** | 0.514 | 0.101 | *-0.528* |
| Immersion | 0.167 | 0.031 | *-0.237* |
| Intuitive | 0.126 | 0.036 | *-0.227* |
| ClearGoals | -0.076 | -0.071 | *-0.127* |
| QualFeedback | -0.091 | 0.017 | *-0.117* |

TABLE 7.8: Structure matrix for the discriminant analysis of games within the "Action" genre. Note, values in italics represent the largest absolute correlation between a variable and a function, while variables in bold represent the variables used to perform the analysis.

In the first dimension, "Half Life 2" scores relatively highly compared to the other games, while "Call of Duty 4" scores relatively poorly. This correlates with the manner in which the two games provide feedback. "Half-Life 2" provides qualitative feedback through in-game actions: enemies recoiling from bullet impacts, obstacles smoking before collapsing, and health packs visibly draining with use, rather than explicitly displaying numbers relating to damage and remaining resources. While the single-player aspect of "Call of Duty 4" operates in a similar fashion, the multiplayer element provides "Experience Points" ("XP") for in-game achievements, in a similar way to most roleplaying games. Similarly, this acts to inform the player of their current game proficiency, as well as to alert the game to "unlock" certain proficiency-based rewards.

In the second dimension, "Halo 3" scores lower in comparison to the other "Action" games. This reflects the game's more "traditional" First-Person Shooter style. "Half-Life 2" switches seamlessly between fast-paced shooting, physics-based puzzle solving and exploratory path-finding. "Call of Duty 4", while primarily combat driven, switches between drastically different theatres of engagement: squad-based patrols, special forces infiltration, political assassinations, and a night-time assault from a flying fortress all feature in the game's story. Conversely, "Halo 3" focuses mainly on shooting enemies with the help of a squad of marines, with the only new skills (and indeed, rewards) being introduced in the form of new weapons and vehicles.

#### 7.5.3.2 Online

In this genre, "teachskills" and "curiosity" accounted for the most variance, while "clear-goals" caused the second most variance.

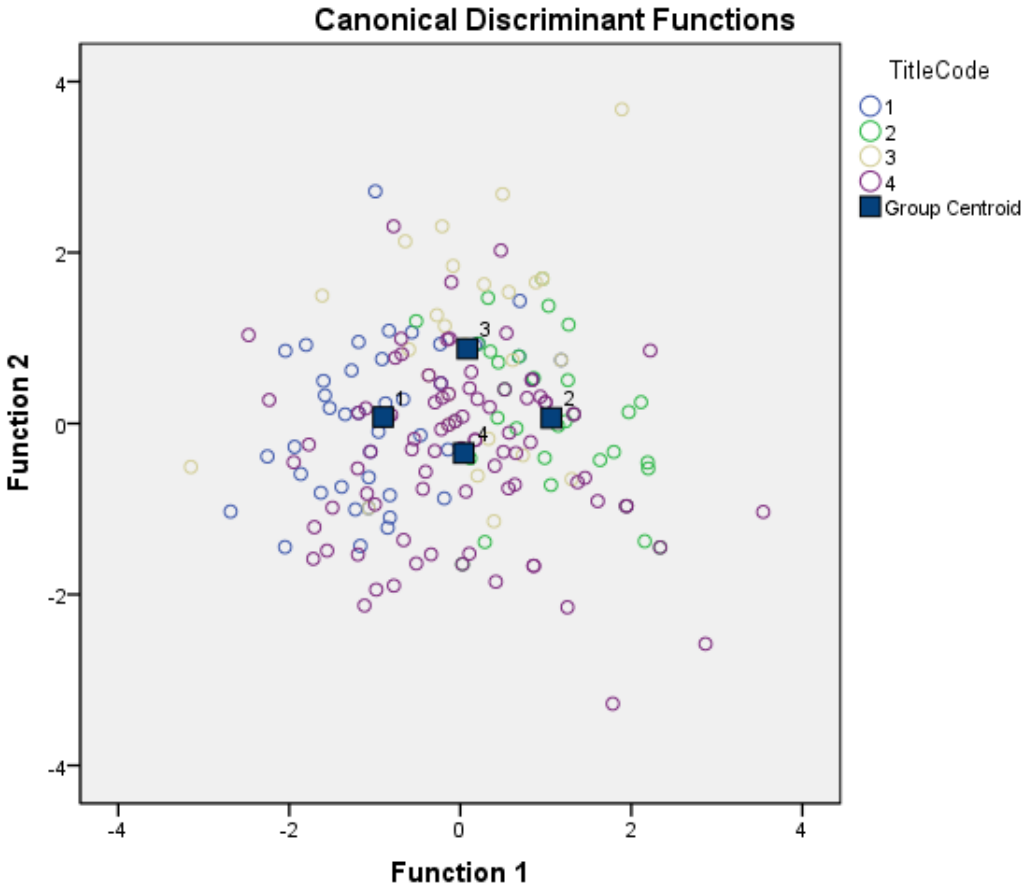


FIGURE 7.4: Online games, plotted against dimension one (good introduction of new skills and provocation of curiosity) and dimension two (clear provision of goals). TitleCodes represent 1) "Counterstrike", 2) "World of Warcraft", 3) "Team Fortress 2" and 4) the assorted remaining Online games.

| Function | | Eigenvalue | % Variance | Cumulative % | Canonical Correlation |
|---|---|---|---|---|---|
| Dimension: | 1 | 0.383 | 61.8 | 61.8 | 0.526 |
| | 2 | 0.174 | 28.2 | 90.0 | 0.385 |
| | 3 | 0.062 | 10.0 | 100.0 | 0.241 |

TABLE 7.9: Eigenvalues for the discriminant analysis of games within the "Online" genre.

In the first dimension, "World of Warcraft" scored relatively highly, while "Counter-strike" scored comparatively poorly. This matches the typical MMORPG features of gradually introducing new items and abilities, while encouraging exploration in a vast, richly populated world. This is corroborated by comparatively high scores in areas

| | Function | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| **Curiosity** | *0.755* | 0.433 | 0.236 |
| **TeachSkills** | *0.717* | -0.078 | -0.053 |
| GameRewards | *0.542* | 0.061 | 0.040 |
| UseSkills | *0.512* | 0.085 | 0.073 |
| SocRewards | *0.343* | -0.039 | 0.021 |
| Unbalanced | *0.313* | -0.060 | 0.016 |
| NonLinear | *0.305* | 0.032 | 0.120 |
| QualFeedback | *0.236* | 0.115 | 0.021 |
| DiffSolutions | *0.186* | 0.129 | 0.139 |
| **ClearGoals** | -0.472 | *0.488* | -0.294 |
| QuantFeedback | 0.157 | *0.251* | 0.031 |
| Comms | 0.105 | *0.183* | 0.095 |
| Intuitive | -0.088 | *0.180* | 0.006 |
| **Immersion** | 0.084 | -0.068 | *0.659* |
| **Mods** | -0.264 | 0.505 | *0.511* |

TABLE 7.10: Structure matrix for the discriminant analysis of games within the "Online" genre. Note, values in italics represent the largest absolute correlation between a variable and a function, while variables in bold represent the variables used to perform the analysis.

such as "gamerewards", "socrewards", "nonlinear", "diffsolutions" and "useskills". Conversely, "Counterstrike" is a much more focused experience, played much like a military training exercise: proceed with your squad through the set routes within the level, and defeat the enemy when you encounter them. Once the layout of a given level is learned, the game becomes a drill in being able to shoot the opponent before they shoot you – an exercise in perfecting one particular skill, rather than assimilating an increasing number of new skills.

"Team Fortress 2" scores more highly in the second dimension than the other "Online" games, and also scores highly for "intuitive", "comms" and "quantfeedback". This reflects the game's simplification of multiplayer First-Person-Shooter game archetypes – simple, clear goals are made clear by the type of match being played, and the player's individual role will be informed by the type of character they choose. By combining these clear goals with equally clear feedback on the player's actions, the resulting game is relatively intuitive – with respect to both the player's immediate responsibilities and the overall goals of the team.

#### 7.5.3.3 Puzzle

While three dimensions were identified for discriminating between "Puzzle" games, only the first offers any significant variance, comprising of two main features – "useskills" and "curiosity".

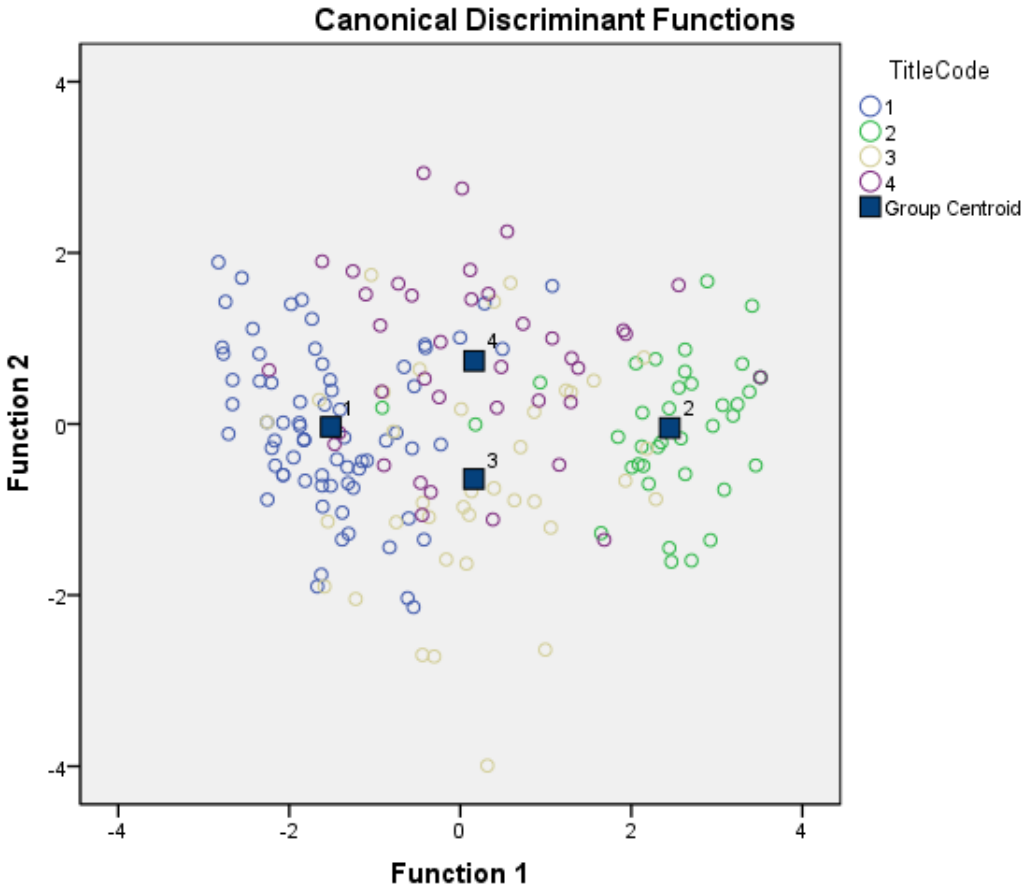


FIGURE 7.5: Puzzle games, plotted against dimension one (consistent use of player's skills and good provocation of curiosity) and dimension two (no significant separation). TitleCodes represent 1) "Tetris", 2) "Portal", 3) "Lemmings" and 4) the assorted remaining Puzzle games.

| Function | | Eigenvalue | % Variance | Cumulative % | Canonical Correlation |
|---|---|---|---|---|---|
| Dimension: | 1 | 2.203 | 86.4 | 86.4 | 0.829 |
| | 2 | 0.199 | 7.8 | 94.2 | 0.408 |
| | 3 | 0.148 | 5.8 | 100.0 | 0.359 |

TABLE 7.11: Eigenvalues for the discriminant analysis of games within the "Puzzle" genre.

| | Function | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| **Curiosity** | *0.795* | 0.460 | 0.090 |
| **UseSkills** | *0.640* | -0.360 | 0.379 |
| TeachSkills | *0.399* | -0.105 | 0.260 |
| DiffSolutions | *0.116* | 0.034 | 0.008 |
| **GameRewards** | 0.105 | *0.492* | 0.265 |
| **NonLinear** | -0.059 | *0.303* | 0.054 |
| QualFeedback | 0.079 | *-0.128* | -0.101 |
| ClearGoals | -0.030 | *-0.047* | -0.003 |
| **Immersion** | 0.403 | -0.034 | *-0.660* |
| **Unbalanced** | -0.087 | -0.218 | *0.540* |
| QuantFeedback | 0.166 | 0.049 | *-0.194* |
| Intuitive | 0.076 | -0.007 | *-0.181* |
| Mods | 0.171 | 0.111 | *0.180* |

TABLE 7.12: Structure matrix for the discriminant analysis of games within the "Puzzle" genre. Note, values in italics represent the largest absolute correlation between a variable and a function, while variables in bold represent the variables used to perform the analysis.

"Portal" scores significantly higher in this dimension than the other "Puzzle" games, while "Tetris" score relatively lower. This separation reflects the differing play styles of the two games. "Portal" gives the player a single main power – the ability to project "portals" onto various surfaces, such that objects (including the player) which enter one portal will emerge from the other as if the two were connected. The application of this ability is introduced gradually over the course of the game, with the player having to negotiate a series of obstacles, hazards and eventually enemies by using the portals to manipulate the physics of the game world. The game has no set solutions, with players free to experiment with the physical properties of the portals in order to reach their goal.

In contrast to this, "Tetris" offers no opportunity for experimentation, nor does it introduce any new skills beyond its core requirement: sort the falling blocks, and don't let them reach the top. In this respect, "Tetris" is similar to "Counterstrike", in that it acts as a drill to improve a single skill, rather than an opportunity to develop a number of skills or understandings within a single context. However, it is slightly different in that where the difficulty in "Counterstrike" increases "organically" as a result of the opposing (human) players becoming more proficient at the game, "Tetris" becomes harder simply by increasing the speed of the falling blocks. In this way, once the game becomes too fast for the player to control, the stack of blocks reaches the top and the game is over. Thus, the game limits its difficulty by never allowing the player to play beyond their means, forcing them to practise again before trying to beat their own score.

#### 7.5.3.4 RPG

This genre is separated by two main features: primarily by "diffsolutions", then by "teachskills".

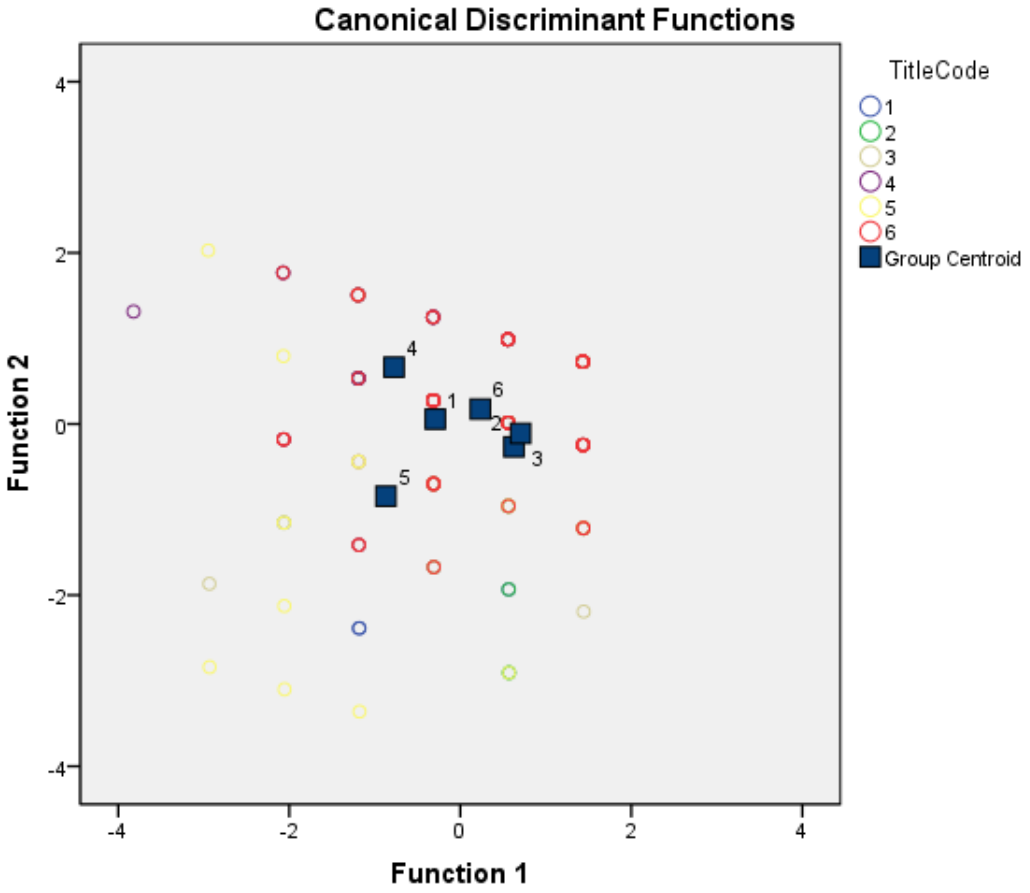


FIGURE 7.6: RPG games, plotted against dimension one (challenges have multiple different solutions) and dimension two (good introduction of new skills). TitleCodes represent 1) "Final Fantasy VII", 2) "Fallout 3", 3) "Oblivion", 4) "Zelda: Ocarina of Time", 5) "Pokemon" and 6) the assorted remaining RPG games.

| Function | | Eigenvalue | % Variance | Cumulative % | Canonical Correlation |
|---|---|---|---|---|---|
| Dimension: | 1 | 0.315 | 66.4 | 6.4 | 0.489 |
| | 2 | 0.159 | 33.6 | 100.0 | 0.371 |

TABLE 7.13: Eigenvalues for the discriminant analysis of games within the "RPG" genre.

Both "Oblivion" and "Fallout 3" score highly in the first dimension. The games are similar (developed by the same studio, using the same game engine), focusing on exploration over a vast environment, and strong customisation of the player character's abilities. Players are free to develop their character as they choose, shaping their skills

| | Function | |
|---|---|---|
| | 1 | 2 |
| **DiffSolutions** | *1.000* | 0.003 |
| NonLinear | *0.380* | 0.127 |
| QualFeedback | *0.352* | 0.216 |
| QuantFeedback | *0.284* | 0.078 |
| Curiosity | *0.237* | 0.182 |
| Intuitive | *0.221* | 0.068 |
| **TeachSkills** | 0.284 | *0.959* |
| UseSkills | 0.357 | *0.420* |
| GameRewards | 0.193 | *0.248* |
| Immersion | 0.215 | *0.240* |
| Unbalanced | 0.009 | *-0.239* |
| ClearGoals | 0.022 | *0.152* |
| Mods | 0.087 | *-0.113* |

TABLE 7.14: Structure matrix for the discriminant analysis of games within the "RPG" genre. Note, values in italics represent the largest absolute correlation between a variable and a function, while variables in bold represent the variables used to perform the analysis.

and equipment to approach the game's challenges in their own unique way. Conversely, both "Zelda: Ocarina of Time" and "Pokemon" both scored relatively poorly in this dimension. This reflected in their more linear style of gameplay. While both games are spread over large areas, the path through these areas is strongly pre-determined. "Zelda" in particular features many "dungeon" style environments, with each room require a specific puzzle to be solved before the player can progress. Typically, such puzzles only have one solution, making novel approaches redundant.

"Zelda" scores more highly in the second dimension, while "Pokemon" scores poorly. This correlates with the way in which "Zelda" introduces new items and abilities throughout the game, requiring the player to assimilate them into their existing skill-set in order to solve the puzzles and defeat the enemies. "Pokemon", on the other hand, introduces its skills quite early in the game, teaching the player everything the need to know in order to catch, train and battle with their monsters. The complexity in "Pokemon" is derived from the monsters' different properties, with each monster having a "type" (e.g. water, fire, electric) which is particularly weak or strong against other types in a rock-paper-scissors fashion. This rock-paper-scissors style of play correlates with the game's low score in "diffsolutions" – there will always be a type of monster that is strong against the one the player is battling, and so the dominant strategy is typically to use that type.

### 7.5.4 Putting It All Together

By combining the peculiarities of the genre-by-genre breakdown with the overall scores listed in Table 7.5.2, we are able to compile a more robust taxonomy of genres and gameplay features. This taxonomy includes some new "emergent" genres, which appear as a result of any discrepancies between an original genre as a whole, and the individual games within it.

The results for the "Action" genre suggest that games within this genre are poor at providing quantitative feedback to their players. However, when the games within the genre were studied separately, only "Half Life 2" scored particularly badly in this respect, with "Call of Duty 4" (the most reviewed game in the genre) actually scoring quite highly. The differences in gameplay styles between these games was noted previously, and is reflected in the choice of new emergent genres: "Action Adventure", which contains story-driven, puzzle-solving action games like "Half Life 2", and "Arcade Action", which contains more traditional "points-scoring" action games.

The "Online" genre scored poorly overall in the "teach new skills" category, and indifferently when provoking curiosity in the player. "World of Warcraft", however, scored well in both of these categories. A strong provocation of curiosity correlates with the results for the RPG genre, as World of Warcraft is an online Roleplaying Game. The majority of other online games were versions of Action games, and so the split between "Online Action" and "Online RPG" seems sensible. While the Online Action genre teaches few new skills throughout the game's duration, and Online RPG will bring introduce new skills (and provoke curiosity) in the style of a traditional offline RPG.

The final new genre emerges from the "Puzzle" genre. In general, Puzzle games were shown to be good at pushing players to use any new skills they had learned throughout the game. When breaking down the puzzle genre, "Tetris" stood out as being poor in this respect. It's less experimental, reflex-heavy gameplay style was contrasted against that of "Portal" and "Lemmings" (the two other most-reviewed Puzzle games), which called for more experimentation with the player's various tools and abilities. As such, the Puzzle game is split into two new sub-genres: "Reflex Puzzle", taking into account block-sorting and colour-matching Puzzle games, such as "Tetris" or "Bejewelled"; and "Experimental Puzzle", including games such as "Portal" and "Lemmings". This split reflects the difference between games which promote drilled practice in a single skill, and those which promote experimentation with a constantly increasing repertoire of skills.

| **Gameplay Features** | **Genre** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Action** | | **Online** | | **Puzzle** | | **RPG** | **Strategy** |
| | **Arcade** | **Adventure** | **Action** | **RPG** | **Reflex** | **Experimental** | | |
| Support communication between players | | | + | + | | | – | |
| Allow players to modify the game, using editing tools or programming APIs | | | | | | | – | |
| Reward the player with in-game resources | | | | | | | + | |
| Reward the player in a socially-visible way | | | + | + | | | – | |
| Teach new skills throughout the game | | | – | + | – | + | | |
| Require that the player use their skills throughout the game | | | | | – | + | | |
| Use difficulty balance to maintain the player's state of Flow | + | + | + | + | – | – | + | |
| Allow the player to complete the game in a non-linear fashion | – | – | | | | | | |
| Provoke curiosity in the player | | | | + | | | + | |
| Foster an immersive environment | + | + | – | – | | | | – |
| Accept different possible solutions for a given problem | | | | | | + | | + |
| Provide qualitative feedback on the player's actions | | | | | + | + | – | |
| Provide quantitative feedback on the player's actions | + | – | | | + | + | | |
| Set out clear goals for the player to achieve | | | | | + | + | – | |
| Provide intuitive interaction mechanisms | | | | | + | + | – | |

TABLE 7.15: The taxonomy of gameplay features present in each different genre, based on the results of the experiment. A "+" indicates strong support of the feature, a "–" indicates weak support, and an empty box indicates a normal level of support

## 7.6 Conclusions

The results of this experiment are sufficient to reject the null hypotheses: there is indeed a positive correlation between the degree to which a given gameplay feature is supported by a game, and how fun that game is perceived to be; and the features offered by different genres of game are not so similar as to be statistically indistinguishable.

These results have a few useful implications. The correlation between measured gameplay features and game quality should be useful to both game developers and educators. Whether developing a game from scratch, or choosing an existing title for educational use, this correlation could indicate that by supporting more of the features (and to a higher degree), the gameplay experience will be improved. The research into educational theory and learning styles presented at the beginning of this thesis already suggests that the features are useful from an educational perspective. The positive correlation between these features and how fun a game is could be the missing link between a game that is both educational and fun to play.

The per-genre features go one step further, highlighting which types of game are especially good (or bad) at supporting different gameplay features. The resulting taxonomy could be used by educational game developers as a guide, when deciding what type of game to design to achieve a particular learning outcome. Where the general correlation between "features" and "fun" could help prevent an educational game from being boring, these more specific guidelines should help to prevent a game being irrelevant to the concept it is trying to convey. By combining the general correlations with the specific, per-genre taxonomy, educational games have the potential to be both fun and relevant to their learning style, while – just as importantly – still being educational.

# Chapter 8

# Conclusions

Based on the results presented in this thesis, a number of conclusions can be drawn.

The initial discussion on existing learning environment research highlighted a number of different requirements for a successful learning environment. Correlation of different authors' work led to a combined set of requirements, which would form the basis for the rest of the research presented in the thesis. The subsequent expert review of gameplay mechanisms led to the conclusion that computer games are capable of satisfying every one of the requirements in a number of ways, and therefore, that computer games have the capacity to act as successful learning environments.

In particular, the review of MMORPGs provided evidence that the gameplay mechanisms typical to the genre not only support social elements of learning, but could also promote scientific thinking, competence building, and learner motivation through provocation of curiosity, difficulty balance and goal provision. A further conclusion drawn from this work suggests that popular MUVE "Second Life" should not strictly be considered a MMORPG for educational purposes, as it lacks almost all of the gameplay mechanisms typical of the genre that lend themselves so well to supporting learning activities.

The discussion of educational theory and learning styles contributed further to the idea that computer games are suitable educational tools. The various elements of each learning style were supported by a corresponding gameplay mechanism from one or more commercially available computer games. In conclusion, every aspect of each examined learning style could be supported by mechanisms present in a computer game.

Combined with the work on learning environments, the conclusion that computer games have the capacity not only to act as useful learning environments, but also that such learning environments could support a wide range of common learning styles. To tie these two ideas together further, each of the learning styles was cross-referenced with the set of learning environment requirements, to create a taxonomy of learning environment

requirements – with the potential to be fully supported by computer games – appropriate to each type of learner.

Having concluded that computer games *can* satisfy the set of requirements for a good educational environment, the next stage was to investigate whether they typically *do*. A selection of 26 educational minigames were examined, to determine how well they supported the different criteria. The majority of games scored poorly in this respect, offering only two or three requirements from the list. These games mainly took the form of quizzes or simple puzzles combined with animated graphics, without any real sense of "gameplay" involved. Some of the games, however, satisfied a much more complete set of requirements, offering rich explorable environments, multiple interesting ways to solve a problem, and a genuine opportunity to build on knowledge gained previously in the game. Two features – the demonstration of new knowledge and the provision of clear goals – were present in nearly all of the games.

The investigation therefore reinforced the conclusion that computer games *can* satisfy the requirements for a good learning environment. However, while some of the criteria were present in almost all of games studied, the majority of games failed to satisfy most of the requirements. The games lacking in most of the features were also typically the least fun to play, being either frustrating, boring, or otherwise confusing in their overall purpose. This leads to the conclusion that there is likely a positive correlation between support for the various educational requirements and the quality of the gameplay experience involved. The complete results for this investigation can be found in Appendix A.

Two investigations into the effects of game genre on the level of educational feature support provided some significant results, both for the individual game genres and for the set of educational requirements in general.

By plotting the results returned for "goodgame" (how enjoyable the questionnaire participant found the game to be) against each of the other gameplay features, a statistically significant, positive correlation was found between the two values for every gameplay element except "Mod Support". This suggests that for each of the positively correlating features, if the level of support for that feature is increased, the enjoyability of the game should also increase. As such, it could be suggested that by increasing what has been determined to be an educational feature in a game, the quality of its gameplay is increased similarly. Thus, it is not only the case that educational elements need not *detract* from the quality of a game; by correctly implementing certain key features that can support the learning process, the gameplay should, by the very nature of these features, be *enhanced*.

The results of the investigation into the "Action" genre suggested a further separation was required, dividing the genre further into "Action-Arcade" and "Action-Adventure" games. These sub-genres shared similarities in their strength at promoting immersion

and balancing difficulty, as well as their relative weakness at offering a varied, non-linear path to completion. However, while the "Arcade" style of Action game offered clear, quantitative feedback for player actions, the "Adventure" style of game was relatively weak in this area, relying primarily on qualitative feedback.

The combination of linearity and well-balanced difficulty could suit a scaffolded learning style, where a restricted course combined with a very specific level of assistance is desirable. This type of game may also suit a behaviourist approach, where, aided by the immersive environment, the "Flow" zone is maintained. However, if quantitative feedback is required as part of the behaviourist "reinforcement schedule", an "Arcade" style of Action game would be more appropriate.

A similar separation emerged when analysing the "Online" genre. A genre-wide trend showed that Online games allowed strong communication between players, socially-visible rewards, and suitable mechanisms to balance difficulty. The environments within these games, however, was not considered to be immersive. The socially-visible rewards offered by both sub-genres could be useful in supporting Instrumental motivation.

By splitting the genre into "Online Action" and "Online RPG", further strengths and weaknesses appear. The Online RPG sub-genre is successful in encouraging the player to develop new skills throughout the whole play experience. Online Action games, on the other hand, tended to rely on a single set of skills for the duration of play. The continual new knowledge offered by an Online RPG, particularly when combined with the genre-wide support for inter-player communication, may suit either a Constructivist learning style, or a vicarious "Modelling" approach to learning.

In addition, the Online RPG was seen to be strong in fostering player curiosity, while the Online Action genre was not. This correlates with the way that typical "offline" Action games force the player into a linear style of play, leaving little room for curiosity-provoking "lures".

The results for the "Puzzle" genre also indicated a further division, resulting in "Reflex Puzzles" and "Experimental Puzzles". Both types of game were seen to excel in their provision of both qualitative and quantitative feedback. There was also a genre-wide trend of stating clear goals for success, and for providing intuitive control interfaces. However, while Experimental Puzzle games were shown to be strong in their introduction and continual development of new skills throughout play, Reflex Puzzles were shown to be much weaker in these areas. To further enhance this development of skills, Experimental Puzzle games appeared to offer more varied routes to completion than the options provided by Reflex Puzzles.

The new knowledge – and the opportunity to contextualise it – provided by an Experimental Puzzle game, combined with the genre-wide support for clear user feedback, could lead to a successful application in supporting Constructivist learners, or equally

a scaffolded learning approach. Combined further with the genre's clarity of goal provision, learners from Bloom's "Applying", "Analysing" or "Evaluating" categories could potentially benefit.

The combination of clear goal provision and clear feedback offered by both types of Puzzle game could potentially enhance an achievement-driven or socially-motivated learner's experience. Combined further with the new knowledge provided by an Experimental Puzzle game, Honey and Mumford's "Reflectors" may also benefit.

The remaining two genres did not require further division, with any emergent trends being applicable across the genre as a whole. The "Strategy" genre returned the most straightforward results, offering a standard provision of all features, with the exception of a variety of solutions (which it provides well), and an immersive environment (which it provides poorly). The variety of solutions may suit Honey and Mumford's "Pragmatists", who prefer to learn by exploring different possibilities.

The "RPG" genre revealed more a more complex set of strengths and weaknesses. Its strengths lay in its ability to provoke curiosity in the player, to reward their actions, and to balance difficulty throughout the duration of play. The combination of balanced difficulty and regular rewards may support a Behaviourist learner, by simultaneously maintaining the "flow" zone and offering the rewards needed to form a strong reinforcement schedule.

Some of its weaknesses are less important when considered in the context of "offline" play – a lack of inter-player communication or socially-visible rewards should not adversely affect a primarily single-player experience. The other weaknesses associated with the genre present more of a problem for certain types of learner. The lack of clear goals or qualitative feedback might hinder a player motivated through "achievement", as well as Honey and Mumford's "Reflectors" and Bloom's "Evaluators". The lack of support for modified content may also deny Bloom's "Creators" the opportunity to generate new material for an existing world.

Through these results, different gaming genres can be seen to support different educational features in different capacities, which in turn may support different learning and teaching styles with varying degrees of success. In addition to these differences, a positive correlation between support for these features and the overall enjoyability of a gameplay experience suggests that supporting these features – regardless of genre – can lead to a more enjoyable game.

# Chapter 9

# Contribution and Future Work

## 9.1 Contribution

The findings presented in this thesis represent a number of useful contributions to the field of educational computer gaming.

Expanding on existing research, a set of requirements was generated for a successful learning environment, bringing together the ideas of different researchers in new ways, forming a more robust requirement set than the authors' individual works. In addition, investigation and experimentation showed that all of these requirements, in some way or another, can be provided by the various gameplay features offered by different types of computer game.

This introduces another contribution: the assertion that the spectrum of computer games is very broad, and that one game is not necessarily the same as another. Games may satisfy the requirements for a learning environment in very different ways, depending on their length, genre, complexity, or whether they are played alone or with others. This assertion is useful in itself, as it reminds us to evaluate each game on its own merits, and not to make sweeping statements about gaming as a whole when analysing, developing, or choosing a game to suit a purpose. Doing so could lead us to make claims which may be true about a specific type of game, but completely untrue of another, jeopardising any future work based on those findings.

An explanation of *how* these games are different develops this idea further. The findings of the more in-depth genre investigation particularly show which features are most useful in distinguishing between genres of game, and gave suggestions as to what those genres might be. The final list of requirements satisfied by each genre should allow instructors, developers and researchers to choose a game based on the requirements it satisfies. By choosing a game in this way, it should support the user's work in a more appropriate way then if a game had been chosen based on more superficial values. While two games

might cover the same theme or idea, the mechanisms they use to convey that idea can be very different. By using this results, the user can see beyond the superficial layer, and select a game based on its underlying mechanisms.

Finally, the criteria were shown to correlate positively with how enjoyable a given computer game was, i.e. games which supported a given feature more successfully were also seen to be more fun. This correlation is important, as it indicates that by supporting the features identified in this thesis, an educational game should indeed be able to achieve both of its intended aims: by being both a good educational tool, and an equally good game.

## 9.2 Future Work

These findings offer significant potential for educational game development and uptake. The initial set of requirements and its representation through different gaming genres will allow games to be understood much more objectively in terms of their educational merit. In order to build on these findings, two main areas of future work have been identified: expand the study to incorporate more varieties of game; and actually use the results to design, or select an appropriate game for use in teaching.

### 9.2.1 Looking Deeper Still

Before the experiments detailed in this thesis were carried out, current research into different gaming genres was found to be lacking. At best, the genres were arbitrarily selected and poorly analysed; at worst, sweeping statements were made about "computer games" as a whole, without any consideration given to the nuances of different game types. However, while this lack of consideration is a problem when dealing with the wide range of modern games, it was not necessarily always the case. In the early stages of popular computer game development, almost all games would have been either text-based "adventure" games, or simple, reflex-based "action" games. As such, broad, catch-all assertions about "computer gaming" would have been more acceptable, because the computer gaming space was much more homogenous.

In the same way, the findings presented in this thesis, while scientifically sound at present, will not necessarily be so in twenty years' time – or in ten years', or even five. We know now that a statement made about "games" twenty years ago is not necessarily applicable to a particular set of modern action games, roleplay games and strategy games. Similarly, a statement made today about "action games" may, in the future, not be equally true of both an action game controlled with a motion-detecting camera, and one played in a live-action "Alternate Reality Game" (ARG) style, or one played online with thousands of other players in a persistent world.

To maintain the relevance of this work, ongoing research will be required in order to catalogue the emergence of new genres as well as evolutions in those which currently exist. By assimilating new data and augmenting the existing results with new findings, the information in the taxonomy can continue to be a useful representation of the features offered by the spectrum of games at any given time.

### 9.2.2 Putting the Results into Action

The true benefits of the results presented in this thesis will be seen in their application in genuine learning activities. By offering a clearer picture of what educational benefits a game can actually offer, the opportunity for an instructor to integrate a truly useful educational game into their learning activity becomes more feasible. To determine just how usable these results are in practise, several further investigations could take place: the results could be used to build something new, or to select something appropriate from the existing set of available games.

#### 9.2.2.1 Building Something New

When designing any computer game (or, indeed, any piece of software, or any type of game), various requirements will be set before the system is built. In general, these could include functional outcomes, expected user experiences, and specific pieces of content. In a learning environment, certain requirements may be stated about learning outcomes, or particular learning styles that are to be supported. In a video game, there may be broad requirements about the genre or theme of the game, or specific requirements about how ofter rewards are given, how the player will interact with certain objects, or whether there will be a multiplayer component.

The results of both the genre-specific and broader gameplay studies could be applied to this design-and-build process. If a gameplay genre is decided first, the results can be used to suggest features that will most likely support that style of play. If a set of learning styles are the primary design requirement, a set of features which support that style can be chosen, and a suitable genre of game can be decided to offer these features most appropriately.

It has yet to be determined how well these results fit into the design process of an educational game. Further experiments are already under way, incorporating this thesis' findings into an innovative software development method called "TAPT". This method aims to deconstruct the desired user experience, distilling the elements which are crucial in supporting the users' expectations, before using them to develop a final design. The experiments will attempt to deconstruct both educational and gameplay experiences, before deciding how best to piece the distilled elements together.

This experiment and other potential future experiments will help to determine not only whether the results of this thesis are useful from a game designer's perspective, but how best to apply them to the design process of an educational game.

#### 9.2.2.2 Taking Games to the Classroom

As well as assessing how the results help to *build* an educational game, it would be useful to know how they help to *use* one. In the same way the results are useless without being applied to the design process, the game itself is useless without being applied to the learning process. Once a game has been designed and developed using the results, experiments will be required in order to assess that game's usefulness as an educational tool, as well as it's value as a game. In turn, the usefulness of this thesis' results will be assessed across the whole software lifecycle – from initial requirements gathering, through the design and build process, right through to the final user experience.

In addition, the results can be used to assess existing games, much like they were in the minigames chapter of this thesis. That chapter covered only a small selection of minigames available at the time, and more will certainly have been developed since the investigation took place. By using the results to pick an existing minigame to support their teaching, an instructor could help to evaluate two things: how useful the results are in evaluating existing products; and how valid the assertion is that minigames are more easily incorporated into a busy lesson than more comprehensive commercial titles.

Whether selecting existing titles, or developing new ones from scratch, the findings of this thesis aim to help instructors find the most suitable game for their educational needs. A suitable experiment as part of some actual instruction will help to determine – from an instructor's perspective – how useful the results really are.

## 9.3 Conclusions

So far, when considering video games in an educational context, any assertions have been either too vague, or too specific. Results or suggestions either relate to one specific game (which offers little in the way of re-use), or to computer gaming as a whole. The results presented here show that to consider video gaming as one homogenous set would overlook countless nuances found between games, and could generate false positive results when asserting games' benefits, or false negatives when branding them as useless.

By using the results found in this thesis, understanding different games in terms of their specific educational strengths and weaknesses, and by evaluating, developing and using video games for education based on these qualities, it is hoped that the community can

ultimately benefit from that Holy Grail of educational gaming: an experience that is both educational, but equally importantly, fun.

# References


Adams, E. (2005), Interactive narratives revisited.
**URL:** *http://www.designersnotebook.com/Lectures/Interactive_Narratives_Revisit/interactive_narratives_revisit.htm*

Aguilera, M. D. & Mendiz, A. (2003), 'Video games and education (education in the face of a parallel school)', *ACM Computers in Entertainment* **1**(1).

Amory, A. (1999), 'The use of computer games as an educational tool: identification of appropriate game types and game elements', *British Journal of Educational Technology* **30**(4).

Amsel, A. (1962), 'Frustrative nonreward in partial reinforcement and discrimination learning', *Psychological Review* **69**(4), 306–328.

Andrade, G., Ramalho, G., Santana, H. & Corruble, V. (2005), Extending reinforcement learning to provide dynamic game balancing, *in* 'IJCAI Workshop on Reasoning, Representation and Learning in Computer Games'.

Bailey, C. & Katchabaw, M. (2005), An experimental testbed to enable auto-dynamic difficulty in modern video games, *in* 'Proceedings of the 2005 GameOn North America Conference'.

Becker, K. & Jacobsen, D. M. (2005), Games for learning: Are schools ready for what's to come?, *in* 'Proceedings of DiGRA 2005 Conference: Changing Views  Worlds in Play'.

Begg, M., Dewhurst, D. & Ellaway, R. (2004), 'Process, truth and consequence; informal reflections on games, game communities and their use within higher education', Short paper presented at Digital Games in Learning colloquium, University of Edinburgh, available online.
**URL:** *http://www.balerno.freeuk.com/truth_con.doc*

Blatchford, P., Kutnick, P., Baines, E. & Galton, M. (2003), 'Towards a social pedagogy of classroom group work', *International Journal of Educational Research* **39**, 153–172.

Bodner, G. M. (1986), 'Constructivism: A theory of knowledge', *Journal of Chemical Education* **63**(10), 873–878.

Boulos, M. N. K., Hetherington, L. & Wheeler, S. (2007), 'Second life: an overview of the potential of 3-d virtual worlds in medical and health education', *Health Information and Libraries Journal* **24**, 233–245.

Chee, F. & Smith, R. (2003), Is electronic community an addictive substance?
**URL:** *http://digra.org:8080/Plone/dl/db/05150.58105.pdf*

Cox, R., McKendree, J., Tobin, R., Lee, J. & Mayes, T. (1999), 'Vicarious learning from dialogue and discourse', *Instructional Science* **27**(6), 431–458.

Csikszentmihalyi, M. (1997), 'Flow and education', *NAMTA Journal* **22**(2).

Delwiche, A. (2003), Mmorpgs in the college classroom, *in* 'Proceedings of The State of Play: Law, Games and Virtual Worlds'.

Dewey, J. (1910), 'Science as subject matter and as method', *Science* **31**(787), 121–127.

Dormans, J. (2006), The hacker: New mythical content of narrative games, *in* 'TIDSE'.

Ducheneaut, N. & Moore, R. J. (2004), The social side of gaming: A study of interaction patterns in a massively multiplayer online game, *in* 'Proceedings of CSCW '04'.

Ducheneaut, N., Yee, N., Nickell, E. & Moore, R. J. (2006), alone together? exploring the social dynamics of massively multiplayer online games, *in* 'Proceedings of CHI 2006: Games and Performances'.

Fabricatore, C. (2000), Learning and videogames: An unexploited synergy, *in* 'The International Conference of the Association for Educational Communications and Technology'.

Facer, K. (2002), Computer games and learning: Why do we think it's worth talking about computer games and learning in the same breath?
**URL:** *http://www.futurelab.org.uk/download/pdfs/research/disc_papers/Computer_Games_and_Learning_discpaper.pdf*

Feather, N. T. (1996), 'Extending the search for order in social motivation', *Psychological Inquiry* **7**(3), 223229.

Fisch, S. M. (2005), Making educational computer games educational, *in* 'Proceedings of IDC 2005'.

Forehand, M. (2005), 'Bloom's taxonomy: Original and revisited', *Emerging perspectives on learning, teaching, and technology* .

Gagné, R. M. (1984), *The Conditions of Learning and the Theory of Instruction*, 4th edn, Holt, Rinehart and Winston.

Gee, J. (2004*a*), Game-like learning: An example of situated learning and implications for opportunity to learn.
**URL:** *http://www.academiccolab.org/resources/documents/Game-Like-Learning.rev.pdf*

Gee, J. (2004*b*), 'Learning by design: Games as learning machines', *Interactive Educational Multimedia* **April**(8), 15–23.

Hobbs, M., Brown, E. & Gordon, M. (2006), 'Using a virtual world for transferable skills in gaming education', *Italics e-journal* **5**(3).

Hogle, J. G. (1996), 'Considering games as cognitive tools: In search of effective edutainment'.
**URL:** *http://twinpinefarm.com/pdfs/games.pdf*

Hunicke, R. & Chapman, V. (2004), Ai for dynamic difficulty adjustment in games, *in* 'Challenges in Game Artificial Intelligence AAAI Workshop'.

Keller, J. M. (1987), 'Development and use of the arcs model of motivational design', *Journal of Instructional Development* **10**(3).

Kemp, J. & Livingstone, D. (2006), Putting a second life "metaverse" skin on learning management systems, *in* 'Second Life Community Convention'.

Kiili, K. & Ketamo, H. (2007), Exploring the learning mechanism in educational games, *in* 'Proceedings of the 29th International Conference on Information Technology Interfaces'.

Kolb, A. Y. & Kolb, D. A. (2005), The kolb learning style inventory – version 3.1, Technical report, Hay Resources Direct.

Koper, R. & Olivier, B. (2004), 'Representing the learning design of units of learning', *Educational Technology & Society* **7**(3).

Laurillard, D. (1999), 'A conversational framework for individual learning applied to the 'learning organisation' and the 'learning society'', *Systems Research and Behavioral Science* **16**(2).

Laurillard, D. (2002), Rethinking university teaching in the digital age.
**URL:** *http:// www.educause.edu /ir/library/pdf/ffp0205s.pdf*

Lee, K. (2002), The online identity and deviant behavior: Who are you in massively multiplayer online role playing game?
**URL:** *http://www.cs.cmu.edu/ sangl/papers/MMORPG-deviantbehavior-paper.pdf*

Machado, A. (1989), 'Operant conditioning of behavioral variability using a percentile reinforcement schedule', *Journal of the Experiemental Analysis of Behavior* **52**(2), 155–166.

Malone, T. W. (1982), Heuristics for designing enjoyable user interfaces: Lessons from computer games., *in* 'Conference on Human Factors in Computing Systems'.

Merrill, M. D. (2004), 'First principles of instruction', *Educational Technology Research and Development* **50**(3).

Mumford, A. (1995), 'Putting learning styles to work: an integrated approach', *Industrial and Commercial Training* **27**(8), 28–35.

Nicholls, J. G. (1984), 'Achievement motivation: Conceptions of ability, subjective experience, task choice and performance', *Psychological Review* **91**(3), 328–346.

Paras, B. & Bizzocchi, J. (2005), Game, motivation, and effective learning: An integrated model for educational game design, *in* 'Proceedings of DiGRA 2005 Conference: Changing Views - Worlds in Play'.

Prensky, M. (2005), 'Complexity matters', *Educational Technology* **45**(4).

Rollings, A. & Adams, E. (2003), *Andrew Rollings and Ernest Adams on Game Design*, New Riders.

Ryan, R. M. & Deci, E. L. (2000), 'Intrinsic and extrinsic motivations: Classic definitions and new directions', *Contemporary Educational Psychology* **25**, 54–67.

Sandelands, L. E., Ashford, S. J. & Dutton, J. E. (1983), 'Reconceptualizing of the overjustification effect: A template-matching approach', *Motivation and Emotion* **7**(3), 229–255.

Spronck, P., Ponsen, M., Sprinkhuizen-Kuyper, I. & Postma, E. (2006), 'Adaptive game ai with dynamic scripting', *Machine Learning* **63**, 217–248.

Spronck, P., Sprinkhuizen-Kuyper, I. & Postma, E. (2004), Difficulty scaling of game ai, *in* 'GAME-ON 2004: 5th International Conference on Intelligent Games and Simulation'.

Squire, K. (2002), 'Cultural framing of computer/video games', *The International Journal of Computer Game Research* **2**(1).

Squire, K. (2005), 'Changing the game: What happens when video games enter the classroom', *Innovate: Journal of Online Education* .

Squire, K. & Barab, S. A. (2004), Replaying history, *in* 'Proceedings of 2004 International Conference of the Learning Sciences'.

Stebbins, W. C. & Lanson, R. N. (1962), 'Response latency as a function of reinforcement schedule', *Journal of the Experiemental Analysis of Behavior* **5**(5), 299–304.

Steinkuehler, C. (2004), Learning in massively multiplayer online games, *in* 'Proceedings of the 6th International Conference on Learning Sciences'.

Steinkuehler, C. A. (2005), Cognition and learning in massively multiplayer online games: A critical approach. Unpublished dissertation.

Steinkuehler, C. & Chmiel, M. (2006), Fostering scientific habits of mind in the context of online play, *in* 'Proceedings of the 7th International Conference on Learning Sciences'.

Vygotsky, L. (1978), *Mind in Society – The Development of Higher Psychological Processes*, Harvard University Press.

Watson, J. B. (1997), *Behaviorism*, Transaction Publishers.

Wenger, E. (1998), 'Communities of practice: Learning as a social system', *Systems Thinker* .
**URL:** *http://ewenger.com/pub/pub_systems_thinker_wrd.doc*

Wood, D., Bruner, J. S. & Ross, G. (1976), 'The role of tutoring in problem solving', *Journal of Psychology and Psychiatry* **17**.

# Appendix A

# Mini-game Investigation Results

The following tables show the complete results for the mini-game investigation, found in chapter 5. The games are listed in the order they appear in the investigation, for ease of translation while reading.

Table A.1: Part 1 of the criteria met by various BBC Schools educational minigames

| **Criterion** | **Aliens** | **Archaeology** | **Battle Atlantic** | **Beckham** | **Diver's Quest** |
|---|---|---|---|---|---|
| Allow conversation between instructor and learner | | | | | |
| Demonstrate new knowledge to the learner | X | X | X | X | X |
| Allow instructors to establish experiential, explorable environments that are contextually relevant | X | | | | |
| Provide opportunity for learners to explore these worlds | X | | | | |
| Allow instructors to provide feedback on the learners' actions | | | | | |
| Provide a customisable balance between boredom and frustration | | X | X | X | |
| Provide the learner with explicit goals | X | X | X | X | X |
| Allow the learner to integrate new information with their existing knowledge | X | X | X | | |
| Motivate the learner by provoking curiosity | | | X | | |
| Promote a sense of immersion within the environment, free of distractions outside the environment's context | | | | | |
| Offer rewards when goals are achieved successfully | | X | | | |
| Unite a number of learning resources in a single environment | | | | | |
| Support blended and full online learning | | | | | |
| Allow the full pedagogical meaning of data to be expressed | X | X | X | | |
| Compatibility with different standards | | | | | |

Table A.2: Part 2 of the criteria met by various BBC Schools educational minigames

| **Criterion** | **Early Church** | **Guy Fawkes** | **History Bluff** | **Historical Targets** | **Journey Deep** |
|---|---|---|---|---|---|
| Allow conversation between instructor and learner | | | | | |
| Demonstrate new knowledge to the learner | X | X | X | X | X |
| Allow instructors to establish experiential, explorable environments that are contextually relevant | | | | | X |
| Provide opportunity for learners to explore these worlds | | | | | X |
| Allow instructors to provide feedback on the learners' actions | | | | | |
| Provide a customisable balance between boredom and frustration | | | | | |
| Provide the learner with explicit goals | X | X | X | X | |
| Allow the learner to integrate new information with their existing knowledge | | | | | X |
| Motivate the learner by provoking curiosity | | X | X | | X |
| Promote a sense of immersion within the environment, free of distractions outside the environment's context | | | | | |
| Offer rewards when goals are achieved successfully | | | | | |
| Unite a number of learning resources in a single environment | | | | | |
| Support blended and full online learning | | | | | |
| Allow the full pedagogical meaning of data to be expressed | | | | | |
| Compatibility with different standards | | X | | | |

Table A.3: Part 3 of the criteria met by various BBC Schools educational minigames

| **Criterion** | **Ice Breaker** | **Life on the Edge** | **Dive to the Abyss** | **Open Ocean** | **Webs of Life** |
|---|---|---|---|---|---|
| Allow conversation between instructor and learner | | | | | |
| Demonstrate new knowledge to the learner | X | X | X | X | X |
| Allow instructors to establish experiential, explorable environments that are contextually relevant | | | | | |
| Provide opportunity for learners to explore these worlds | | X | X | | X |
| Allow instructors to provide feedback on the learners' actions | | | | | |
| Provide a customisable balance between boredom and frustration | X | X | | | X |
| Provide the learner with explicit goals | X | X | X | X | X |
| Allow the learner to integrate new information with their existing knowledge | X | X | X | | X |
| Motivate the learner by provoking curiosity | X | X | X | | |
| Promote a sense of immersion within the environment, free of distractions outside the environment's context | | X | X | | |
| Offer rewards when goals are achieved successfully | | | | X | |
| Unite a number of learning resources in a single environment | | | | | |
| Support blended and full online learning | | | | | |
| Allow the full pedagogical meaning of data to be expressed | X | X | X | X | X |
| Compatibility with different standards | | | | | |

Table A.4: Part 4 of the criteria met by various BBC Schools educational minigames

| **Criterion** | **California Coast** | **Nervous System** | **Lost Army** | **Destination Death** | **Spherox** |
|---|---|---|---|---|---|
| Allow conversation between instructor and learner | | | | | |
| Demonstrate new knowledge to the learner | X | X | | X | X |
| Allow instructors to establish experiential, explorable environments that are contextually relevant | | | | | |
| Provide opportunity for learners to explore these worlds | | | | X | X |
| Allow instructors to provide feedback on the learners' actions | | | | X | |
| Provide a customisable balance between boredom and frustration | | | | X | X |
| Provide the learner with explicit goals | X | X | X | X | X |
| Allow the learner to integrate new information with their existing knowledge | | | | X | |
| Motivate the learner by provoking curiosity | | | | X | |
| Promote a sense of immersion within the environment, free of distractions outside the environment's context | | | X | X | |
| Offer rewards when goals are achieved successfully | | | X | | X |
| Unite a number of learning resources in a single environment | | X | | X | |
| Support blended and full online learning | | | | | |
| Allow the full pedagogical meaning of data to be expressed | X | X | | X | X |
| Compatibility with different standards | | | | | |

Table A.5: Part 5 of the criteria met by various BBC Schools educational minigames

| **Criterion** | **World War When?** | **Apostrophes** | **Termites** | **Memory Maze** |
|---|---|---|---|---|
| Allow conversation between instructor and learner | | | | |
| Demonstrate new knowledge to the learner | | X | | |
| Allow instructors to establish experiential, explorable environments that are contextually relevant | | | | |
| Provide opportunity for learners to explore these worlds | | | | |
| Allow instructors to provide feedback on the learners' actions | X | X | | |
| Provide a customisable balance between boredom and frustration | X | X | | |
| Provide the learner with explicit goals | X | X | X | X |
| Allow the learner to integrate new information with their existing knowledge | | | | |
| Motivate the learner by provoking curiosity | | | | |
| Promote a sense of immersion within the environment, free of distractions outside the environment's context | | | X | |
| Offer rewards when goals are achieved successfully | | | | |
| Unite a number of learning resources in a single environment | | | | |
| Support blended and full online learning | | | | |
| Allow the full pedagogical meaning of data to be expressed | X | X | | |
| Compatibility with different standards | | | | |

# Appendix B

# Experimental Details

This appendix elaborates on the in-depth genre study, providing details on experimental techniques and ethical considerations, as well as the raw data gathered from the experiment.

## B.1 Experimental Techniques

The experiment took the format of an online questionnaire, in which participants were asked to select a set of computer games, and to state how strongly they agreed with a number of statements made about each game. Each statement related to a particular gameplay feature proposed in the thesis. The questionnaire was broken down into five sections (one per game), with participants asked whether they "completely disagree", "strongly disagree", "slightly disagree", "slightly agree", "strongly agree" or "completely agree" with each of the following statements.

1. While playing this game, I can communicate easily with other players
2. I am able to create modifications (levels, weapons, units etc.) to this game, that can be used by other players
3. This game rewards my success in a way that helps me in-game
4. This game rewards my success in a way that can easily be seen by other players
5. This game continues to introduce new skills throughout the course of play
6. The game provides opportunities to use the skills I've learned in new and interesting situations
7. I found the game (or parts of the game) to be either too hard to progress, or too easy to maintain my interest

8. In playing this game, I am not restricted to a single linear path
9. The game includes objects, areas or characters that provoke curiosity
10. When playing the games, I feel immersed in the game it represents
11. When presented with a problem in the game, I can use a number of different methods to solve it
12. The game reliably informs me when I perform an in-game action
13. The game accurately tells me how *well* I perform an in-game action
14. The goals of the game are always made clear
15. The interface to the game is intuitive
16. The game is fun

Once all of the data had been gathered, the numerical scores associated with each answer – ranging from 1 ("completely disagree") to 6 ("completely agree") – were used to assess how well each game succeeded in providing the different gameplay features relating to each of the sixteen statements. This data was then analysed using the statistical techniques from chapter 7.

## B.2 Ethical Considerations

No invasive procedures were carried out during the experiment, and participants were free to withdraw their involvement at any time. The online questionnaire was used to collect game titles and numerical scores assigned to various categories. The only item of "sensitive" data that participants were asked to provide was an email address. Provision of this address was entirely voluntary, and was only required if the participant wished to enter the prize draw (one entry into the random draw per complete questionnaire; first prize of a Sony Playstation 3 console, three runners-up prizes of 40 "Game" vouchers). Email addresses were stored in a separate database, along with a non-reversible hash of the participant's answers.

## B.3 Raw Data

The following tables contain the average scores achieved by each game reviewed in the survey, with respect to how they satisfied each of the desired criteria.

| Game Title | Co | M | GR | SR | TS | US | U | NL | Cu | Im | DS | QlF | QnF | CG | Int | GG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Advance Wars | 3.714 | 3.571 | 3.714 | 3.571 | 4.429 | 4.714 | 3.714 | 4.286 | 3.714 | 3.571 | 5.286 | 5.000 | 5.000 | 5.571 | 4.857 | 5.286 |
| Age of Empires | 4.000 | 3.500 | 3.000 | 3.250 | 4.750 | 4.750 | 2.500 | 6.000 | 3.500 | 4.750 | 5.500 | 4.500 | 2.750 | 4.000 | 5.000 | 5.250 |
| Age of Empires 2 | 5.000 | 1.000 | 1.000 | 1.000 | 5.000 | 5.000 | 3.000 | 6.000 | 2.000 | 5.000 | 6.000 | 3.000 | 3.000 | 5.000 | 5.000 | 5.000 |
| Age of Empires 3 | 3.000 | 4.000 | 6.000 | 3.000 | 6.000 | 5.000 | 5.000 | 4.000 | 3.000 | 5.000 | 0.000 | 4.000 | 3.000 | 4.000 | 5.000 | 3.000 |
| Age of Empires II | 5.333 | 3.000 | 4.667 | 4.667 | 4.667 | 3.667 | 3.667 | 4.667 | 4.000 | 3.667 | 4.667 | 5.667 | 3.667 | 5.667 | 5.000 | 5.333 |
| Age of Empires: Age of Conquerors | 5.000 | 6.000 | 6.000 | 6.000 | 5.000 | 4.000 | 2.000 | 3.000 | 5.000 | 5.000 | 5.000 | 5.000 | 5.000 | 6.000 | 5.000 | 6.000 |
| Age of Mythology | 5.000 | 5.000 | 5.000 | 5.000 | 6.000 | 4.000 | 2.000 | 5.000 | 4.000 | 4.000 | 4.000 | 4.000 | 3.000 | 4.000 | 5.000 | 6.000 |
| Assassin's Creed | 1.000 | 1.000 | 5.000 | 4.000 | 4.000 | 4.000 | 2.000 | 4.000 | 5.000 | 6.000 | 5.000 | 5.000 | 4.000 | 5.000 | 6.000 | 6.000 |
| Baldur's Gate | 2.000 | 5.000 | 6.000 | 2.000 | 6.000 | 6.000 | 2.000 | 5.000 | 6.000 | 6.000 | 5.000 | 6.000 | 6.000 | 5.000 | 6.000 | 6.000 |
| Battle for Wesnoth | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 3.000 | 3.000 | 1.000 | 6.000 | 2.000 | 6.000 | 6.000 | 6.000 | 6.000 | 3.000 | 6.000 |
| Battlefield 1942 | 5.063 | 3.063 | 4.438 | 4.500 | 4.125 | 4.313 | 2.938 | 4.375 | 3.813 | 4.500 | 4.625 | 4.500 | 4.313 | 4.875 | 4.688 | 5.313 |
| Battlefield 2 | 5.000 | 3.333 | 5.333 | 5.000 | 3.333 | 3.333 | 2.000 | 5.667 | 3.667 | 5.000 | 5.000 | 4.333 | 4.000 | 4.667 | 4.333 | 6.000 |
| Battlefield 2142 | 6.000 | 3.000 | 6.000 | 5.500 | 2.500 | 3.000 | 2.000 | 5.000 | 2.500 | 3.500 | 5.000 | 4.000 | 3.000 | 5.500 | 4.000 | 6.000 |
| Bioshock | 1.000 | 1.000 | 5.000 | 4.000 | 6.000 | 5.000 | 2.000 | 5.000 | 5.000 | 6.000 | 5.000 | 5.000 | 4.000 | 5.000 | 5.000 | 6.000 |
| C&C | 4.000 | 5.000 | 4.000 | 3.000 | 1.000 | 2.000 | 4.000 | 2.000 | 4.000 | 4.000 | 4.000 | 3.000 | 3.000 | 4.000 | 5.000 | 4.000 |
| C&C 3 | 5.000 | 5.000 | 3.000 | 4.000 | 4.000 | 5.000 | 4.000 | 3.000 | 4.000 | 4.000 | 4.000 | 5.000 | 4.000 | 6.000 | 5.000 | 5.000 |
| C&C 3: Tiberian Wars | 6.000 | 3.000 | 6.000 | 3.000 | 2.000 | 3.000 | 2.000 | 1.000 | 3.000 | 3.000 | 5.000 | 3.000 | 1.000 | 6.000 | 4.000 | 6.000 |
| C&C Generals | 4.500 | 5.000 | 5.000 | 5.500 | 4.500 | 5.500 | 3.500 | 6.000 | 4.000 | 5.000 | 5.500 | 5.000 | 3.500 | 4.500 | 4.500 | 5.500 |
| C&C Generals: Zero Hour | 5.000 | 5.000 | 4.000 | 6.000 | 5.000 | 6.000 | 4.000 | 6.000 | 3.000 | 4.000 | 6.000 | 5.000 | 4.000 | 5.000 | 6.000 | 6.000 |
| C&C Red Alert | 5.000 | 0.000 | 4.000 | 4.000 | 4.000 | 4.000 | 4.000 | 5.000 | 4.000 | 3.000 | 4.000 | 5.000 | 3.000 | 5.000 | 5.000 | 4.000 |
| C&C Red Alert 2 | 4.500 | 4.000 | 2.500 | 5.000 | 3.500 | 3.500 | 3.000 | 5.000 | 3.500 | 4.500 | 5.000 | 5.000 | 4.500 | 4.500 | 5.500 | 5.500 |
| C&C Red Alert 3 | 5.000 | 4.000 | 3.500 | 4.000 | 2.500 | 3.000 | 3.500 | 5.000 | 1.500 | 4.500 | 4.000 | 4.500 | 4.000 | 5.000 | 4.500 | 5.000 |
| C&C Red Alert: Ground Zero | 4.000 | 1.000 | 6.000 | 6.000 | 4.000 | 5.000 | 3.000 | 6.000 | 6.000 | 6.000 | 6.000 | 5.000 | 6.000 | 6.000 | 5.000 | 5.000 |
| Call of Duty 4 | 4.377 | 2.580 | 4.870 | 4.870 | 3.899 | 3.928 | 2.913 | 3.014 | 3.551 | 4.754 | 3.623 | 4.449 | 3.942 | 5.087 | 4.913 | 5.478 |
| City of Heroes | 6.000 | 1.000 | 5.000 | 5.000 | 5.000 | 3.000 | 4.000 | 3.000 | 5.000 | 4.000 | 3.000 | 4.000 | 3.000 | 4.000 | 5.000 | 6.000 |
| Civilization IV | 3.654 | 3.346 | 4.846 | 4.038 | 4.308 | 3.885 | 3.923 | 4.885 | 3.769 | 4.038 | 5.192 | 4.808 | 4.500 | 4.808 | 4.615 | 4.962 |
| Clive Barker's Jericho | 1.000 | 1.000 | 4.000 | 2.000 | 4.000 | 5.000 | 2.000 | 2.000 | 5.000 | 6.000 | 3.000 | 5.000 | 4.000 | 5.000 | 5.000 | 6.000 |
| Company of Heroes | 3.917 | 3.500 | 4.000 | 3.667 | 4.250 | 4.417 | 3.667 | 4.167 | 3.833 | 4.083 | 4.583 | 4.667 | 4.250 | 4.917 | 5.167 | 5.083 |
| Counterstrike | 5.302 | 4.512 | 4.372 | 4.488 | 3.047 | 3.512 | 2.814 | 4.651 | 3.116 | 4.744 | 4.558 | 4.628 | 4.186 | 5.302 | 5.093 | 5.326 |

Table B.1: Average scores achieved by each reviewed game, for each of the assessed criteria. Table headings represent Comms, Mods, GameRewards, SocRewards, TeachSkills, UseSkills, Unbalanced, NonLinear, Curiosity, Immersion, DiffSolutions, QualFeedback, QuantFeedaback, ClearGoals, Intuitive and GoodGame.

| Game Title | Co | M | GR | SR | TS | US | U | NL | Cu | Im | DS | QlF | QnF | CG | Int | GG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crossfire | 6.000 | 6.000 | 6.000 | 5.000 | 4.000 | 5.000 | 1.000 | 5.000 | 4.000 | 6.000 | 5.000 | 5.000 | 4.000 | 6.000 | 6.000 | 6.000 |
| Crysis | 6.000 | 6.000 | 6.000 | 5.000 | 6.000 | 6.000 | 1.000 | 6.000 | 5.000 | 0.000 | 6.000 | 6.000 | 6.000 | 5.000 | 6.000 | 6.000 |
| Crysis Wars | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 2.000 | 6.000 | 5.000 | 6.000 | 6.000 | 5.000 | 4.000 | 5.000 | 5.000 | 6.000 |
| Dark Chronicle | 1.000 | 1.000 | 6.000 | 1.000 | 6.000 | 6.000 | 2.000 | 2.000 | 5.000 | 6.000 | 2.000 | 5.000 | 3.000 | 4.000 | 5.000 | 5.000 |
| Deus Ex | 2.545 | 3.000 | 5.545 | 2.273 | 5.273 | 5.182 | 2.909 | 4.636 | 5.364 | 5.455 | 5.091 | 4.909 | 4.636 | 4.727 | 4.818 | 5.364 |
| Devil May Cry 3 | 1.000 | 1.000 | 6.000 | 6.000 | 5.000 | 5.000 | 3.000 | 2.000 | 5.000 | 6.000 | 2.000 | 3.000 | 4.000 | 3.000 | 3.000 | 6.000 |
| Devil May Cry 4 | 1.000 | 1.000 | 5.000 | 1.000 | 4.000 | 4.000 | 3.000 | 1.000 | 4.000 | 5.000 | 2.000 | 5.000 | 5.000 | 5.000 | 6.000 | 6.000 |
| Dofus MMORPG | 5.000 | 6.000 | 6.000 | 6.000 | 6.000 | 5.000 | 4.000 | 6.000 | 6.000 | 4.000 | 5.000 | 5.000 | 5.000 | 3.000 | 5.000 | 5.000 |
| Doom 3 | 2.500 | 2.333 | 4.333 | 2.167 | 4.000 | 3.833 | 2.833 | 2.667 | 4.833 | 5.500 | 3.500 | 4.333 | 3.167 | 4.833 | 5.167 | 5.333 |
| Dungeon Siege 2 | 5.000 | 2.000 | 6.000 | 3.000 | 3.000 | 4.000 | 4.000 | 2.000 | 6.000 | 6.000 | 3.000 | 5.000 | 5.000 | 6.000 | 5.000 | 5.000 |
| Dynasty Warriors | 3.200 | 2.200 | 5.400 | 3.600 | 3.600 | 3.200 | 3.600 | 3.200 | 4.800 | 3.800 | 3.200 | 4.800 | 3.800 | 5.400 | 5.000 | 5.400 |
| EVE Online | 5.571 | 1.714 | 5.714 | 5.571 | 5.571 | 5.571 | 4.714 | 6.000 | 5.000 | 5.571 | 5.571 | 5.429 | 4.143 | 3.286 | 4.143 | 5.286 |
| Evony | 6.000 | 1.000 | 5.000 | 6.000 | 4.000 | 3.000 | 4.000 | 4.000 | 3.000 | 3.000 | 5.000 | 5.000 | 5.000 | 5.000 | 5.000 | 5.000 |
| Fable | 2.000 | 1.875 | 5.250 | 3.063 | 5.000 | 4.688 | 2.875 | 5.063 | 5.063 | 4.750 | 4.313 | 4.750 | 4.188 | 4.375 | 4.563 | 5.063 |
| Fallout 3 | 2.577 | 3.308 | 5.308 | 4.000 | 4.731 | 4.769 | 3.231 | 4.769 | 5.346 | 5.154 | 5.077 | 4.923 | 4.308 | 4.077 | 4.154 | 5.115 |
| Far Cry | 3.143 | 3.286 | 3.714 | 3.143 | 4.429 | 4.286 | 4.143 | 4.286 | 4.429 | 5.286 | 4.429 | 4.429 | 3.714 | 4.429 | 5.000 | 5.000 |
| Far Cry 2 | 5.000 | 4.000 | 2.000 | 5.000 | 5.000 | 5.000 | 1.000 | 3.000 | 4.000 | 6.000 | 4.000 | 5.000 | 4.000 | 5.000 | 5.000 | 6.000 |
| Final Fantasy VII | 2.324 | 2.243 | 5.054 | 3.108 | 4.784 | 4.568 | 3.297 | 4.000 | 5.027 | 4.973 | 4.027 | 4.568 | 4.351 | 4.189 | 4.378 | 5.324 |
| Final Fantasy XII | 5.000 | 1.000 | 5.000 | 6.000 | 6.000 | 5.000 | 4.000 | 5.000 | 5.000 | 6.000 | 3.000 | 4.000 | 4.000 | 5.000 | 5.000 | 6.000 |
| Freespace 2 Open | 4.000 | 6.000 | 6.000 | 3.000 | 5.000 | 5.000 | 1.000 | 2.000 | 5.000 | 6.000 | 6.000 | 6.000 | 5.000 | 6.000 | 6.000 | 6.000 |
| Gary's Mod | 2.000 | 5.000 | 4.000 | 5.000 | 6.000 | 6.000 | 1.000 | 2.000 | 6.000 | 6.000 | 2.000 | 4.000 | 4.000 | 5.000 | 6.000 | 6.000 |
| God of War | 1.857 | 1.429 | 4.857 | 3.143 | 5.000 | 4.857 | 2.857 | 2.143 | 3.714 | 4.857 | 2.857 | 4.571 | 4.000 | 4.571 | 4.429 | 5.286 |
| GTA 4 | 6.000 | 4.000 | 6.000 | 6.000 | 6.000 | 6.000 | 1.000 | 6.000 | 6.000 | 6.000 | 6.000 | 5.000 | 6.000 | 6.000 | 6.000 | 6.000 |
| Guild Wars | 5.455 | 2.455 | 5.455 | 5.818 | 5.455 | 5.000 | 3.000 | 4.545 | 4.636 | 4.818 | 4.545 | 5.091 | 4.273 | 4.455 | 4.636 | 5.455 |
| Half Life | 3.000 | 4.000 | 4.000 | 4.000 | 5.000 | 5.000 | 4.000 | 2.000 | 5.000 | 5.000 | 4.000 | 5.000 | 3.000 | 3.000 | 4.000 | 5.000 |
| Half Life 2 | 3.381 | 3.786 | 3.857 | 3.357 | 4.405 | 4.976 | 2.476 | 2.643 | 4.976 | 5.190 | 4.048 | 4.548 | 3.214 | 4.214 | 5.214 | 5.738 |
| Halo | 5.000 | 2.000 | 4.000 | 4.500 | 4.000 | 4.000 | 1.500 | 1.000 | 2.000 | 1.500 | 2.000 | 2.000 | 2.000 | 2.500 | 2.500 | 2.500 |
| Halo 3 | 4.483 | 3.552 | 3.069 | 4.586 | 3.103 | 3.552 | 3.034 | 2.655 | 4.138 | 4.724 | 3.690 | 4.379 | 3.966 | 4.448 | 4.724 | 5.379 |
| Halo 3 Online | 6.000 | 1.000 | 2.000 | 6.000 | 1.000 | 3.000 | 3.000 | 3.000 | 2.000 | 4.000 | 6.000 | 5.000 | 6.000 | 5.000 | 4.000 | 6.000 |
| Indigo Prophecy | 6.000 | 2.000 | 6.000 | 4.000 | 6.000 | 5.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 5.000 | 5.000 | 6.000 | 4.000 | 6.000 |

TABLE B.2: Average scores achieved by each reviewed game, for each of the assessed criteria. Table headings represent Comms, Mods, GameRewards, SocRewards, TeachSkills, UseSkills, Unbalanced, NonLinear, Curiosity, Immersion, DiffSolutions, QualFeedback, QuantFeedaback, ClearGoals, Intuitive and GoodGame.

| Game Title | Co | M | GR | SR | TS | US | U | NL | Cu | Im | DS | QlF | QnF | CG | Int | GG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Katamari Damacy | 3.200 | 2.200 | 3.600 | 2.600 | 2.800 | 2.800 | 3.800 | 5.400 | 4.400 | 4.000 | 4.200 | 4.000 | 3.800 | 5.400 | 5.200 | 5.200 |
| Killzone 2 | 4.000 | 1.000 | 4.000 | 4.000 | 4.000 | 3.000 | 4.000 | 1.000 | 3.000 | 4.000 | 3.000 | 5.000 | 4.000 | 5.000 | 4.000 | 3.000 |
| Left 4 Dead | 5.000 | 2.000 | 2.500 | 5.000 | 3.000 | 4.000 | 1.500 | 2.000 | 5.000 | 5.000 | 5.000 | 2.500 | 3.500 | 5.500 | 6.000 | 5.500 |
| Lemmings | 1.486 | 2.486 | 2.703 | 2.189 | 3.919 | 4.324 | 3.730 | 2.595 | 2.730 | 2.973 | 4.000 | 3.811 | 3.649 | 4.892 | 4.486 | 4.865 |
| Little Big Planet | 4.000 | 6.000 | 2.000 | 5.000 | 2.000 | 4.000 | 2.000 | 4.000 | 4.000 | 4.000 | 4.000 | 5.000 | 4.000 | 4.000 | 5.000 | 5.000 |
| LOTR: Battle for Middle-Earth 2 | 4.389 | 3.611 | 4.444 | 4.222 | 4.556 | 4.111 | 2.889 | 4.611 | 3.944 | 4.333 | 4.778 | 4.278 | 3.944 | 4.556 | 4.611 | 4.889 |
| Mass Effect | 2.462 | 2.000 | 5.462 | 3.077 | 5.000 | 4.769 | 3.769 | 4.923 | 5.077 | 5.231 | 4.692 | 4.538 | 4.385 | 4.462 | 4.462 | 5.231 |
| Master of Orion II | 4.000 | 3.000 | 3.000 | 3.000 | 2.000 | 2.000 | 2.000 | 5.000 | 4.000 | 4.000 | 2.000 | 5.000 | 5.000 | 5.000 | 5.000 | 5.000 |
| Max Payne | 2.000 | 4.000 | 3.000 | 3.000 | 5.000 | 5.000 | 4.000 | 4.000 | 5.000 | 5.000 | 4.000 | 4.000 | 3.000 | 3.000 | 4.000 | 5.000 |
| Medievel 2: Total War | 3.611 | 3.778 | 4.222 | 3.667 | 3.889 | 4.278 | 3.944 | 5.222 | 3.944 | 4.333 | 4.611 | 4.333 | 4.111 | 4.833 | 4.667 | 4.944 |
| Metal Gear Solid | 2.000 | 2.000 | 5.000 | 4.000 | 4.000 | 5.000 | 1.000 | 2.000 | 6.000 | 6.000 | 5.000 | 4.000 | 4.000 | 5.000 | 6.000 | 6.000 |
| Meteos | 3.000 | 3.500 | 4.000 | 3.500 | 3.000 | 3.500 | 3.000 | 4.500 | 3.500 | 3.000 | 3.000 | 3.000 | 4.000 | 3.000 | 3.500 | 3.000 |
| Metroid Prime | 1.889 | 1.000 | 4.889 | 1.778 | 5.222 | 4.667 | 3.222 | 3.778 | 5.111 | 4.556 | 3.000 | 4.778 | 3.000 | 4.444 | 4.778 | 5.222 |
| Monkey Island | 3.000 | 3.000 | 6.000 | 6.000 | 6.000 | 6.000 | 2.000 | 5.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 4.000 | 5.000 | 6.000 |
| Oblivion | 1.958 | 3.792 | 5.667 | 3.542 | 4.917 | 5.167 | 3.542 | 5.375 | 5.375 | 5.250 | 5.167 | 4.833 | 4.000 | 4.750 | 4.458 | 5.458 |
| Peggle | 1.611 | 1.667 | 3.722 | 2.889 | 3.722 | 3.444 | 3.278 | 2.611 | 2.778 | 2.778 | 3.611 | 3.944 | 4.278 | 5.556 | 5.278 | 5.167 |
| Perimeter | 3.000 | 5.000 | 4.000 | 3.000 | 4.000 | 4.000 | 3.000 | 4.000 | 5.000 | 4.000 | 4.000 | 5.000 | 4.000 | 5.000 | 4.000 | 5.000 |
| Pikmin | 2.500 | 1.333 | 4.000 | 3.167 | 4.500 | 4.833 | 4.167 | 3.333 | 4.500 | 4.500 | 3.500 | 4.000 | 3.500 | 3.833 | 4.167 | 4.667 |
| Pirates of the Caribbean | 1.000 | 2.000 | 6.000 | 1.000 | 5.000 | 5.000 | 4.000 | 6.000 | 5.000 | 6.000 | 5.000 | 5.000 | 4.000 | 3.000 | 5.000 | 6.000 |
| Planetside | 6.000 | 1.000 | 6.000 | 5.000 | 6.000 | 4.000 | 2.000 | 6.000 | 5.000 | 5.000 | 4.000 | 6.000 | 5.000 | 5.000 | 5.000 | 6.000 |
| Pokemon | 2.636 | 2.409 | 5.136 | 4.136 | 3.682 | 3.727 | 2.909 | 3.182 | 4.500 | 4.091 | 3.364 | 4.227 | 4.227 | 4.045 | 4.318 | 4.864 |
| Portal | 1.846 | 3.282 | 3.179 | 2.923 | 4.949 | 5.538 | 2.590 | 2.590 | 5.128 | 5.103 | 4.051 | 4.564 | 3.846 | 4.667 | 5.231 | 5.718 |
| Puzzle Quest | 2.833 | 1.500 | 4.500 | 3.333 | 3.833 | 3.500 | 2.833 | 3.500 | 3.500 | 2.000 | 3.333 | 4.167 | 4.167 | 5.167 | 5.000 | 4.500 |
| Quake | 6.000 | 5.000 | 1.000 | 1.000 | 2.000 | 5.000 | 2.000 | 4.000 | 5.000 | 6.000 | 2.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 |
| Quake 3 | 3.000 | 5.000 | 5.000 | 5.000 | 1.000 | 2.000 | 2.000 | 2.000 | 2.000 | 5.000 | 4.000 | 2.000 | 5.000 | 5.000 | 5.000 | 6.000 |
| Quake 3 Arena | 6.000 | 0.000 | 4.000 | 5.000 | 2.000 | 4.000 | 3.000 | 5.000 | 2.000 | 5.000 | 5.000 | 5.000 | 3.000 | 6.000 | 6.000 | 6.000 |
| Quake 3: Arena | 5.200 | 4.400 | 4.100 | 5.000 | 3.800 | 4.100 | 2.400 | 3.600 | 2.400 | 4.000 | 3.500 | 5.000 | 4.800 | 5.500 | 5.000 | 5.400 |
| Quake Wars | 5.000 | 4.000 | 4.000 | 5.000 | 4.000 | 2.000 | 3.000 | 2.000 | 5.000 | 6.000 | 3.000 | 5.000 | 4.000 | 5.000 | 5.000 | 5.000 |
| Rainbow Six: Vegas | 4.750 | 1.500 | 3.750 | 4.250 | 3.250 | 3.500 | 3.000 | 2.500 | 2.500 | 3.500 | 3.250 | 4.500 | 3.250 | 4.500 | 3.500 | 5.000 |
| Resident Evil 5 | 4.000 | 1.000 | 5.000 | 4.000 | 2.000 | 5.000 | 3.000 | 1.000 | 5.000 | 5.000 | 1.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 |

TABLE B.3: Average scores achieved by each reviewed game, for each of the assessed criteria. Table headings represent Comms, Mods, GameRewards, SocRewards, TeachSkills, UseSkills, Unbalanced, NonLinear, Curiosity, Immersion, DiffSolutions, QualFeedback, QuantFeedaback, ClearGoals, Intuitive and GoodGame.

| Game Title | Co | M | GR | SR | TS | US | U | NL | Cu | Im | DS | QlF | QnF | CG | Int | GG |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rome: Total War | 4.000 | 1.000 | 5.000 | 5.000 | 5.000 | 5.000 | 2.000 | 6.000 | 5.000 | 6.000 | 5.000 | 5.000 | 5.000 | 4.000 | 3.000 | 6.000 |
| Runescape | 6.000 | 1.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 6.000 | 2.000 | 1.000 | 6.000 | 6.000 | 1.000 | 3.000 | 3.000 |
| S.T.A.L.K.E.R. | 3.222 | 3.111 | 4.556 | 3.667 | 4.556 | 4.667 | 4.000 | 5.222 | 5.111 | 4.889 | 4.444 | 4.000 | 3.556 | 4.000 | 4.444 | 5.000 |
| Sins of a Solar Empire | 6.000 | 0.000 | 6.000 | 6.000 | 6.000 | 6.000 | 4.000 | 5.000 | 2.000 | 3.000 | 4.000 | 5.000 | 6.000 | 3.000 | 5.000 | 5.000 |
| Soldat | 5.000 | 4.000 | 4.000 | 2.000 | 4.000 | 4.000 | 3.000 | 4.000 | 5.000 | 4.000 | 4.000 | 4.000 | 3.000 | 5.000 | 3.000 | 6.000 |
| Spellforce: The Order of Dawn | 2.000 | 4.000 | 5.000 | 2.000 | 6.000 | 6.000 | 3.000 | 4.000 | 6.000 | 6.000 | 5.000 | 5.000 | 5.000 | 5.000 | 6.000 | 6.000 |
| Star Wars: Battlefront | 4.500 | 3.400 | 4.000 | 4.000 | 3.300 | 3.200 | 3.300 | 3.800 | 4.000 | 4.700 | 4.500 | 4.600 | 4.200 | 4.600 | 4.100 | 4.600 |
| Star Wars: KOTOR | 3.500 | 2.500 | 5.000 | 3.500 | 5.000 | 5.000 | 3.000 | 5.500 | 5.500 | 6.000 | 6.000 | 5.500 | 4.500 | 4.000 | 4.500 | 5.500 |
| Starcraft | 4.533 | 4.667 | 3.733 | 3.600 | 4.333 | 4.800 | 3.733 | 3.867 | 3.933 | 4.467 | 4.667 | 4.933 | 4.133 | 4.667 | 4.933 | 5.533 |
| Super Puzzle Fighter 2 | 1.500 | 1.500 | 2.500 | 3.500 | 3.000 | 4.500 | 4.500 | 2.000 | 4.500 | 3.000 | 4.000 | 3.500 | 2.500 | 5.000 | 5.500 | 5.000 |
| Supreme Commander | 4.308 | 4.308 | 3.538 | 3.846 | 3.923 | 4.154 | 2.846 | 4.385 | 3.846 | 4.154 | 4.846 | 4.769 | 3.615 | 4.692 | 4.692 | 5.231 |
| Team Fortress 2 | 5.536 | 4.286 | 4.786 | 5.179 | 3.964 | 4.036 | 2.571 | 4.536 | 4.429 | 4.321 | 4.929 | 4.821 | 4.464 | 5.393 | 5.321 | 5.750 |
| Tetris | 1.507 | 1.493 | 2.563 | 2.549 | 2.056 | 2.211 | 3.141 | 3.000 | 1.394 | 2.732 | 3.563 | 4.197 | 3.662 | 5.296 | 5.014 | 4.577 |
| Theme Hospital | 2.000 | 1.000 | 2.000 | 1.000 | 4.000 | 4.000 | 4.000 | 6.000 | 2.000 | 2.000 | 5.000 | 4.000 | 4.000 | 5.000 | 4.000 | 5.000 |
| Timesplitters | 2.714 | 3.143 | 4.000 | 4.286 | 3.286 | 4.429 | 3.143 | 2.857 | 4.000 | 4.286 | 4.000 | 4.714 | 4.429 | 5.143 | 4.857 | 5.429 |
| Total Annihilation | 4.333 | 5.333 | 3.667 | 4.333 | 3.333 | 4.000 | 2.000 | 4.000 | 4.000 | 4.667 | 4.667 | 4.667 | 4.000 | 4.667 | 4.667 | 5.333 |
| Trash Panic | 2.000 | 1.000 | 3.000 | 4.000 | 4.000 | 4.000 | 4.000 | 2.000 | 2.000 | 2.000 | 4.000 | 5.000 | 4.000 | 5.000 | 5.000 | 4.000 |
| Unreal Tournament | 4.000 | 5.000 | 5.000 | 4.000 | 2.000 | 2.000 | 3.000 | 4.000 | 2.000 | 4.000 | 4.000 | 3.000 | 3.000 | 5.000 | 4.000 | 5.000 |
| Unreal Tournament 2004 | 5.118 | 4.471 | 3.588 | 4.471 | 3.176 | 3.706 | 2.824 | 3.588 | 3.000 | 4.118 | 4.176 | 4.471 | 4.000 | 5.000 | 5.000 | 5.471 |
| Urban Terror | 6.000 | 5.000 | 1.000 | 4.000 | 1.000 | 5.000 | 4.000 | 5.000 | 4.000 | 5.000 | 5.000 | 5.000 | 4.000 | 5.000 | 5.000 | 6.000 |
| War of the Worlds | 2.000 | 1.000 | 2.000 | 2.000 | 2.000 | 2.000 | 6.000 | 3.000 | 1.000 | 1.000 | 3.000 | 2.000 | 2.000 | 2.000 | 2.000 | 3.000 |
| Warcraft III | 4.808 | 4.846 | 4.115 | 4.538 | 4.038 | 4.077 | 3.346 | 3.615 | 4.577 | 4.654 | 4.231 | 4.269 | 3.692 | 5.038 | 4.962 | 5.346 |
| Warhawk | 5.500 | 3.000 | 5.000 | 6.000 | 3.500 | 4.500 | 2.000 | 5.500 | 2.500 | 5.000 | 3.000 | 4.500 | 4.500 | 5.000 | 3.500 | 4.500 |
| WH40K: Dawn of War | 2.000 | 1.000 | 2.000 | 2.000 | 4.000 | 4.000 | 5.000 | 1.000 | 2.000 | 3.000 | 5.000 | 2.000 | 4.000 | 3.000 | 4.000 | 5.000 |
| WH40K: Dawn of War 2 | 4.000 | 2.364 | 4.909 | 4.000 | 4.273 | 4.364 | 3.545 | 4.091 | 4.000 | 4.818 | 4.636 | 4.273 | 4.182 | 5.000 | 4.818 | 5.545 |
| World of Warcraft | 5.613 | 3.677 | 5.645 | 5.548 | 4.968 | 4.968 | 4.032 | 5.226 | 5.161 | 5.032 | 4.419 | 5.129 | 4.548 | 4.258 | 4.806 | 5.161 |
| Worms 2 | 4.000 | 2.000 | 2.000 | 2.000 | 4.000 | 4.000 | 3.000 | 4.000 | 5.000 | 3.000 | 6.000 | 4.000 | 5.000 | 5.000 | 3.000 | 5.000 |
| Zelda: Ocarina of Time | 1.957 | 2.000 | 4.913 | 2.783 | 5.261 | 4.826 | 3.304 | 4.348 | 4.783 | 4.391 | 3.478 | 4.217 | 3.478 | 4.000 | 4.870 | 5.087 |
| Zelda: Twilight Princess | 1.000 | 1.000 | 5.000 | 5.000 | 5.000 | 6.000 | 4.000 | 4.000 | 6.000 | 5.000 | 5.000 | 6.000 | 4.000 | 3.000 | 5.000 | 6.000 |

TABLE B.4: Average scores achieved by each reviewed game, for each of the assessed criteria. Table headings represent Comms, Mods, GameRewards, SocRewards, TeachSkills, UseSkills, Unbalanced, NonLinear, Curiosity, Immersion, DiffSolutions, QualFeedback, QuantFeedaback, ClearGoals, Intuitive and GoodGame.